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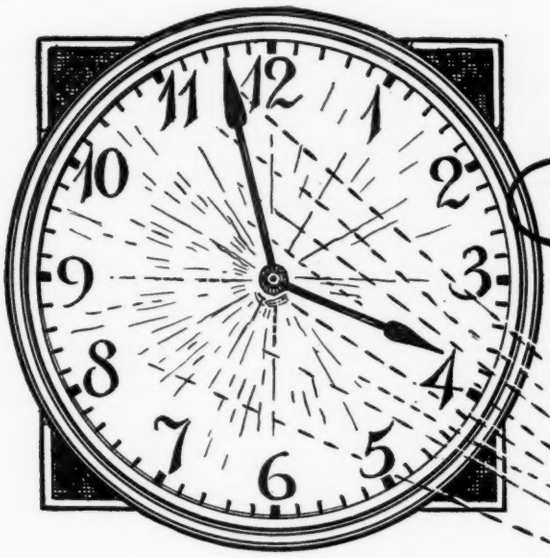


The Shirker

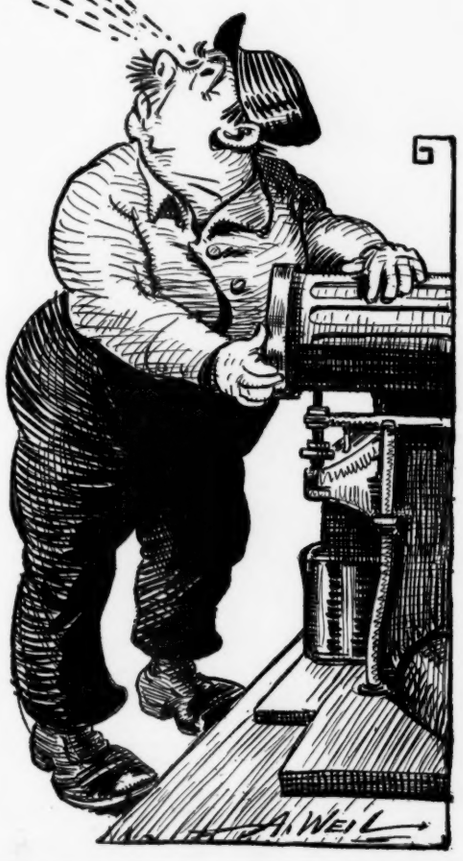
By Rufus T. Strohm

HE TOILS with one eye on the clock
And notes the minutes swiftly flitting,
And so he always leads the flock
That throngs the exit gates at quitting.
He hates the starting whistle's chime
That sounds of work and calls him to it,
And never labors overtime
Unless he knows he's paid to do it.

Square dealing as a working plan
Is so old-fashioned he would spurn it;
His motto reads "Get all you can,
But give the least you must, to earn it."
If he should chance to find a leak
With profits daily wasting through it,
He probably would scorn to speak,
Because he isn't paid to do it.

He loafs along from day to day,
Contented with his low position,
Since drawing down his meager pay
Is quite the height of his ambition.
The thing that might be termed his brain
Has gone to seed, if he but knew it,
For he avoids all mental strain,
Because he isn't paid to do it.

Until the day they close his eyes
And summon in the undertaker,
This foolish man will never rise
Above the level of the faker.
While hosts of others in the race
Will seize the honors they're pursuing,
Because they strive to do with grace
The things they aren't paid for doing.



Appleton Water-Steam Plant

By THOMAS WILSON

Low-head water plant and modern high-pressure system installation arranged on the unit plan, containing electric-driven auxiliaries, economizers and special vacuum regulation of steam supply to replace the usual atmospheric relief.

FOR years the Wisconsin Traction, Light, Heat and Power Co., of Appleton, Wis., has been supplying light and power to the home city and surrounding towns and in addition current for street-railway and interurban service. The plant is situated between the Fox River and the Government Canal, Fig. 1, the latter being about 100 ft. wide at this point. The topography of the site was such that it was possible to utilize the water for power purposes.

Two hydraulic units were provided, each consisting of two 500-kw. machines, one generating alternating current for power and lighting and the other direct current for railway service. The two generators of each unit were driven by three pairs of low-head water-wheels mounted on a common shaft, a tandem-compound

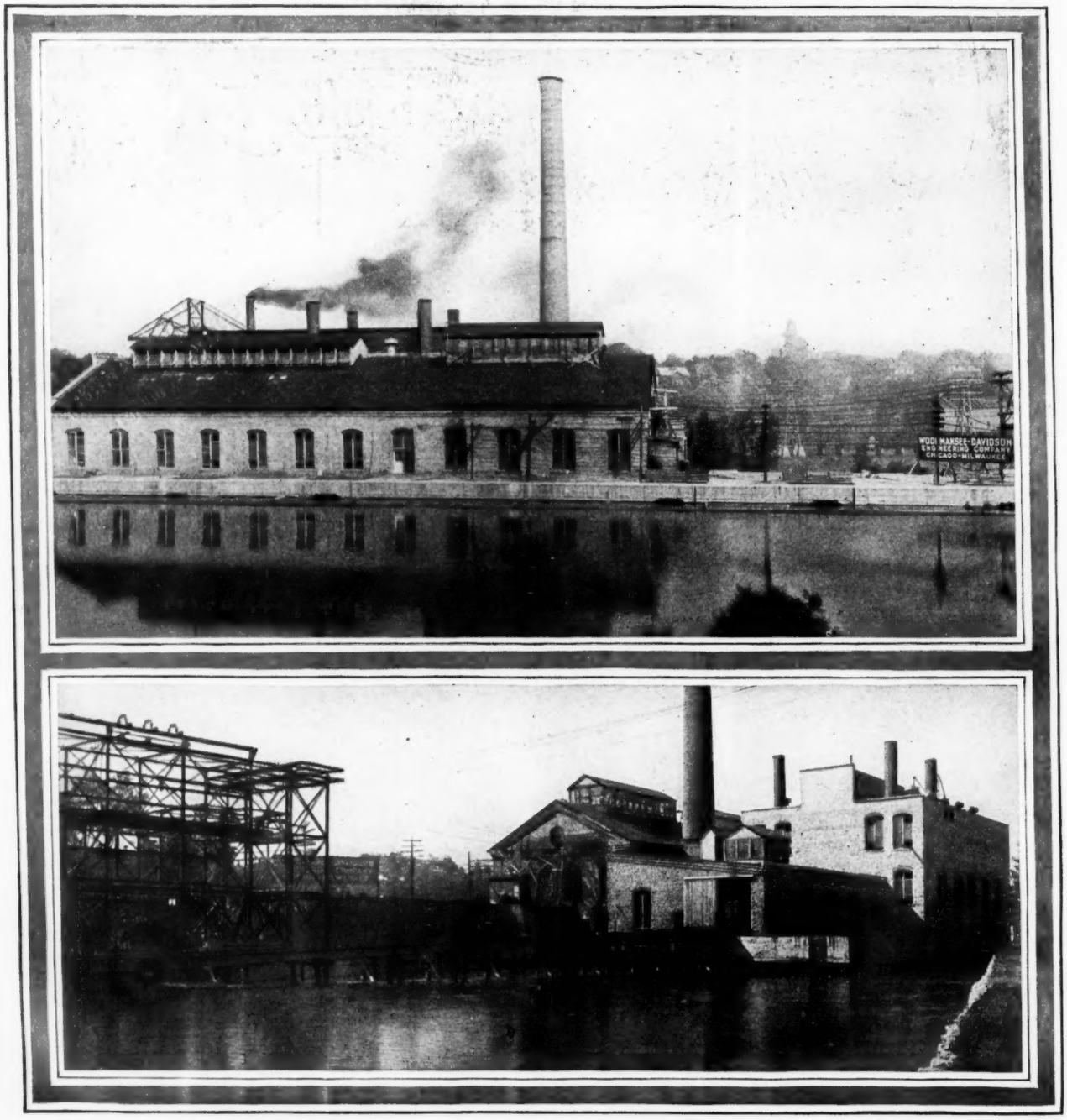


FIG. 1. POWER PLANT FROM RIVER AND CANAL SIDE, LOWER VIEW SHOWING PART OF OUTDOOR SUBSTATION

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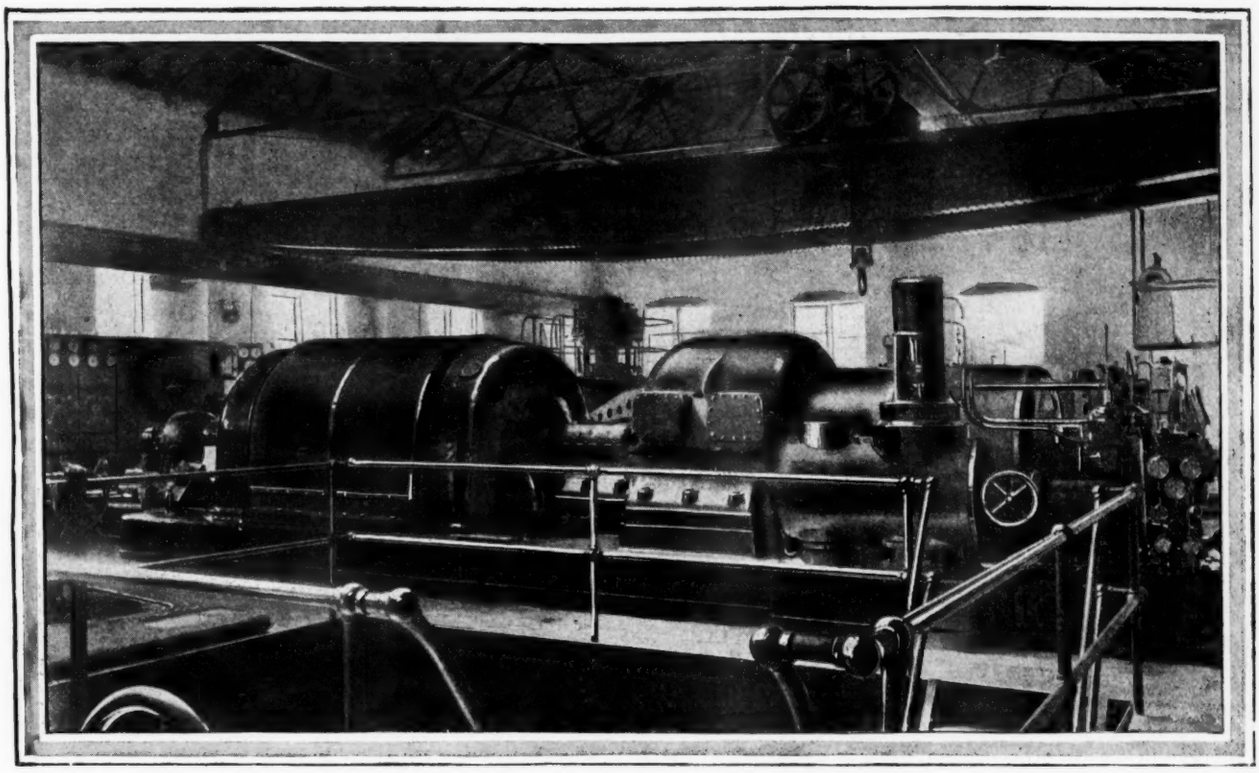

FIG. 2. GENERAL VIEW OF THE TURBINE ROOM

condensing Corliss engine on the other end insuring stand-by service. In winter when the canal was frozen up or at times of low water it was necessary to operate the engines. Magnetic couplings in the shaft readily permitted the use of either prime mover.

With an increasing load the demand for more generating capacity was met by the installation of two 1250-kw. alternating-current low-pressure condensing turbo-generators that utilized the exhaust from the Corliss engines when their services were required, and if need be drew some high-pressure steam from the boiler room. The equipment here consisted of four Stirling boilers and Jones underfeed stokers. Coal came into the boiler room over a railway trestle and was dumped in front of the boilers. The stack was of brick, rising 150 ft. above the boiler-room floor line. It was 70 in. diameter all the way up.

Again, increasing demands and future prospects made it necessary to enlarge the plant. The work was put into the hands of Woodmansee & Davidson, consulting engineers, of Chicago. According to present-day standards the old equipment was not economical. It was decided to remove the waterwheel end of one unit and extend the building back from the canal to house a modern steam and hydraulic plant. The new addition contains two 650-kv.-a. single-runner vertical-shaft hydraulic turbines, two 5000-kw. steam turbines, Fig. 2, with space for two more, and to serve the turbines four 767-hp. water-tube boilers. Space has also been provided for a duplicate installation of boilers which will be needed by the future turbines. The steam plant is arranged on the unit system, electric-driven auxiliaries make economizers profitable, both forced and induced draft are available and the coal- and ash-handling facilities are of the simple character common in the latest plants. The balance of the older equipment still remains and will be utilized as need be. In the near future it is probable that the second of the old waterwheel units will be replaced by hydraulic turbines similar to those in the new section of the plant.

Fig. 3 shows the present layout. The hydraulic turbines are placed on the canal side of the plant and are interposed midway between the center lines of the steam turbines. Back of these units are the boilers arranged on either side of a central firing aisle. The first floor of the old plant is the basement of the new addition. The condensers and water-supply pumps are located here, and as the tailrace from the hydraulic units runs directly underneath, the water supply is unusually convenient.

As will be seen in Fig. 4, the elevation of the tail water is 90 ft., that of the basement floor, 94.55 ft., and the turbine- and boiler-room floors, on a line with the top of the canal wall, 110.33 ft. In the turbine room the roof girders are 20 ft. above the floor, and in the boiler plant the headroom is 37 ft. to permit of a high setting over underfeed stokers and to accommodate the economizers and induced-draft outfit over the boilers. The coal bunker is located over the firing aisle, and the penthouse immediately above, containing the monorail coal hoist, adds 13 ft. to the height of this section of the boiler room.

The new boiler room contains four Springfield Flanner cross-drum boilers arranged in batteries of two on either side of a central aisle, Fig. 5. Each boiler contains 7670 sq.ft. of heating surface and a Foster superheater designed to give 125 deg. of superheat. The operating pressure is 250 lb. gage. As usual with this type of boiler, the tubes are vertically baffled to give three passes for the gases. The bottom of the

front header being 10 ft. above the floor line, gives the combustion space necessary for large overloads. It is the intention to operate the boilers up to 200 per cent. of rating. The stokers are of the new Moloch underfeed

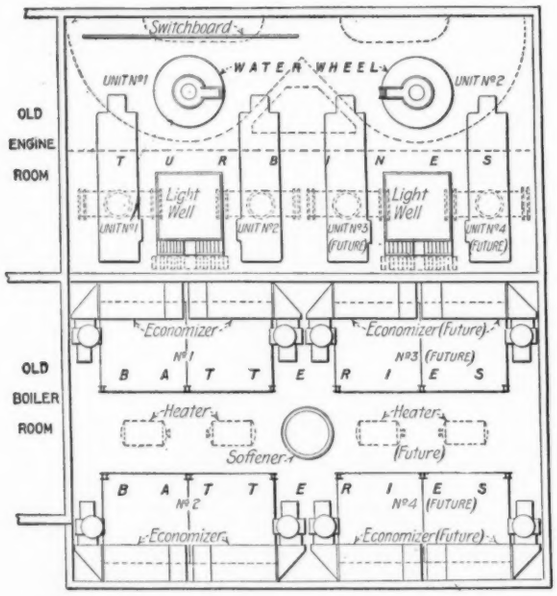

FIG. 3. GENERAL LAYOUT OF NEW STATION

boilers through an automatic timing controller actuated by the fan engine.

Forced draft is supplied to the stoker equipment of each boiler by a 140-in. American Blower steel-plate fan, direct-connected to one 7 x 8-in. Troy horizontal throttling self-oiling inclosed engine. Each blowing unit is capable of delivering sufficient air to operate each boiler at 250 per cent. of normal rating.

The speed of all four blowers is automatically regulated by the boiler pressure of 250 lb., with a Mason damper regulator operating a balanced valve in each of the fan-engine supply lines. The blower unit also drives, by means of a shaft, a timing arrangement which regulates the fuel supply to the boiler. Thus each boiler has an individual stoker and blowing equipment providing for the automatic control of fuel and air supply in accordance with the load demands.

The stoker cylinders and the blower engine are supplied with steam by an auxiliary header at 150 lb. pressure; this steam pressure passing through the fan-engine regulating valve is, however, regulated by the 250-lb. boiler pressure.

On each boiler front is mounted a Republic flow meter with an indicating instrument at the boiler and recording and integrating instruments in the office of the engineer. It is the intention to install a combination draft and blast gage on each unit and an

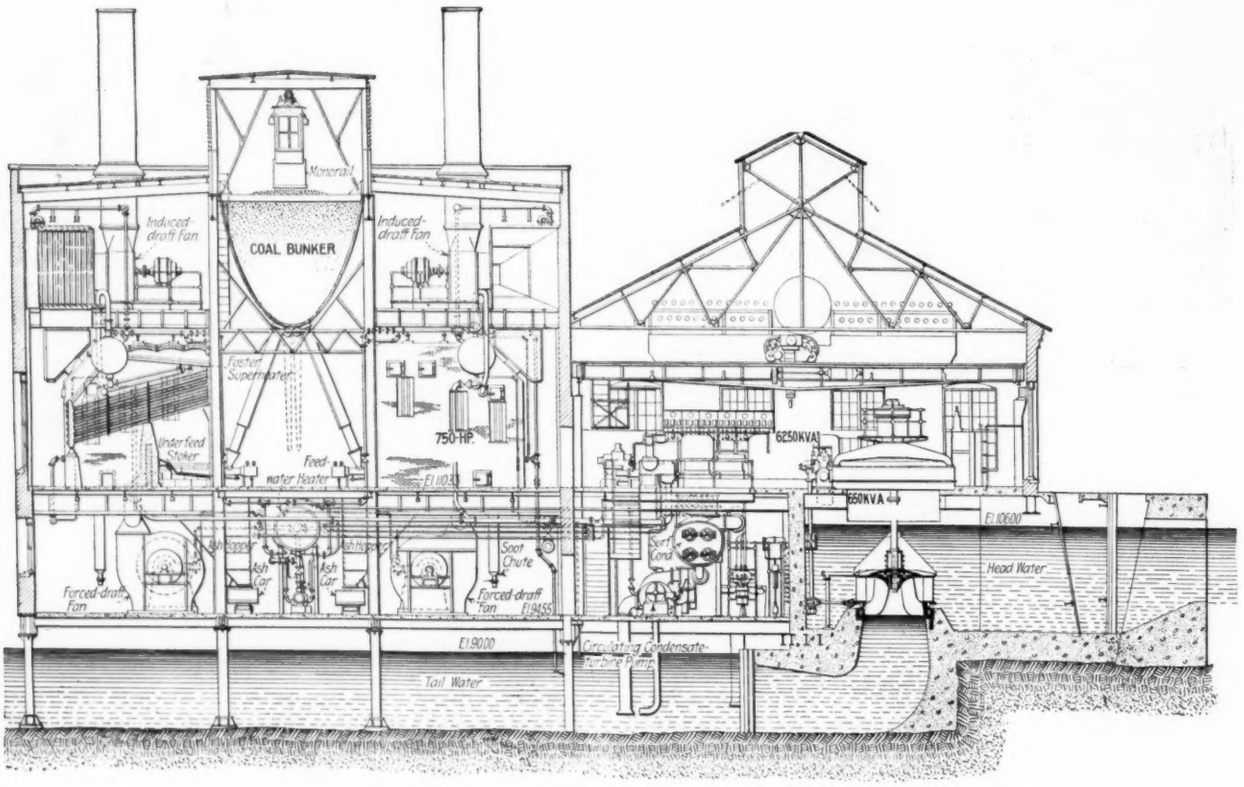

FIG. 4. SECTIONAL ELEVATION THROUGH STATION

type described in the Nov. 7, 1916, issue of *Power*. In the present installation four retorts are used per boiler. The valves of the stoker cylinder are steam-actuated. Youghiogheny coal is burned, and the amount fed to the furnace in conjunction with the quantity of air supplied is regulated by the steam pressure in the

indicating and recording pyrometer with the thermocouple in the third pass of the boiler.

The ash, which is continuously removed by the rotary grinders, drops into a steel hopper underneath the furnace, Fig. 6. It is removed by industrial cars operating on tracks underneath each row of boilers.

These tracks converge to an elevator having a turntable. At the top of a 45-ft. lift the car is given a 90-deg. turn and is pushed over an ash bunker provided with a chute discharging into railway cars on the coal track. By the same means soot is removed from the combustion chamber to the rear of the bridge-wall, the delivery being made through a chute leading to the basement.

From the third pass the gases of combustion are drawn upward to the rear of the cross-drum through a breeching opening into an individual economizer by a motor-driven induced-draft fan. The gases escape to atmosphere through a 54-in. steel stack placed on top of the fan and rising 20 ft. above the roof. It makes an interesting comparison with the brick stack serving the older plant. The use of the individual economizer is becoming favorite practice. The present case is featured by the omission of a bypass. Work on the interior of the economizer might necessitate a shutdown of the entire unit, but this would be infrequent and there is sufficient reserve capacity to permit such a contingency.

The economizers are of the Sturtevant special high-pressure type designed for a water pressure of 375 lb. All pressure parts are semi-steel castings having a tensile strength of 39,500 lb. per sq.in. The tubes are $\frac{7}{16}$ in. thick and the headers $\frac{9}{16}$ in. The assembled economizer has an ultimate strength of 2000 lb. per sq.in., giving an actual factor of safety of eight at the specified boiler pressure, 250-lb. gage.

Each economizer has 216 nine-foot tubes arranged in 24 sections of nine tubes each, and for four-section group circulation. The heating surface totals 2685 sq.ft. and the water capacity 13,608 lb. With the water entering at 130 deg. and the gases at 500 to 600 deg., depending upon the load, it is estimated that the economizer will raise the temperature of the water approximately 100 deg. At normal load the fan, a No. 10 multivane, at a speed of 235 r.p.m., will give $\frac{3}{8}$-in. draft at the boiler uptake, requiring 5 hp. to handle 25,000 cu.ft. of gas per minute at an approximate temperature of 375 deg. At 200 per cent. of boiler rating the fan may be speeded up to 385 r.p.m., giving $\frac{3}{4}$-in. draft at the boiler uptake and requiring 25 hp. to handle 50,000 cu.ft. of gas per minute at the temperature previously given.

The steam piping as shown in the elevation, Fig. 4, is arranged on the unit plan. Opposing boilers of each battery connect to a common 8-in. line supplying one of the turbines, although there is a cross-connection, so that any pair of boilers may supply either turbine. From the top of the boiler cross-drum the steam is conducted to the superheater, the outgoing connection dropping to the basement and crossing over under the main-floor level to the turbines. The bends care for expansion, and suitable hangers support the piping from the basement ceiling. On the high-pressure steam lines all joints are of the Van Stone type to withstand the high pressure and superheat, and the valves are Crane steel-body, monel-trimmed, with cooling chambers under the glands. Wilcox gaskets with asbestos composition fillers are used.

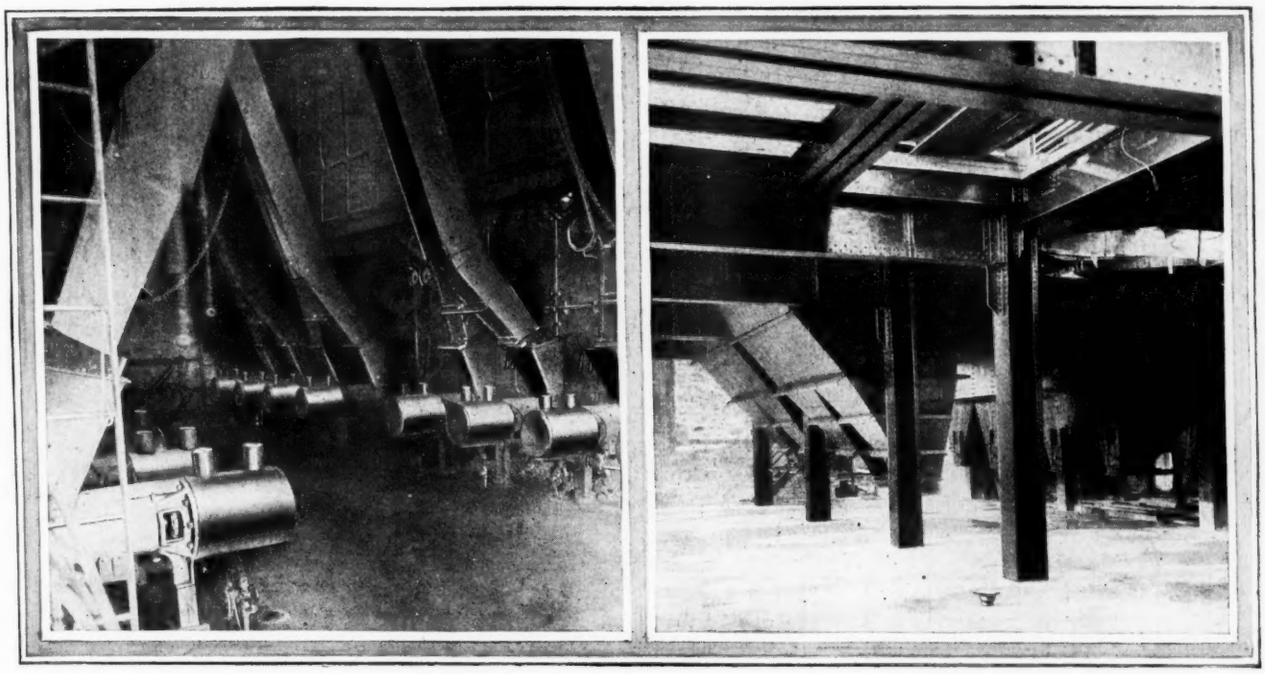

FIG. 5. CENTRAL FIRING AISLE IN BOILER ROOM

FIG. 6. ASH HOPPER UNDER BOILERS

All water for the plant comes from the tailrace under the basement floor. Raw water is used for house service, but the water for boiler makeup, for sealing glands, for the oil coolers, etc., is softened in a Bartlett-Graver softener and quartz filter having a capacity of 2000 gal. per hour. One 2-in. and two 3-in. motor-driven centrifugal pumps handle the supply of raw and softened water, each pump having double suction and double discharge connections, so that it may be used in either service.

From the soft-water line a connection under float control is made to each feed-water heater. Of the latter there are two of the Hoppes open type, each rated at 4000 hp., and in accordance with the unit plan, serving

a boiler of each battery. Each heater is elevated on pipe supports, and underneath is a 70-hp. Allis-Chalmers turbine driving a multi-stage feed pump having capacity to deliver at 3000 r.p.m. 200 gal. per min. against a head of 650 ft., or 280 lb. gage. The suction connections permit the supply to come under head either from the heater or the soft-water line, and the discharge is double, one connection leading to either boiler, ordinarily through the economizer, or if need be through a bypass directly to the boiler. The feed may be introduced into the cross-drum or through the blowoff

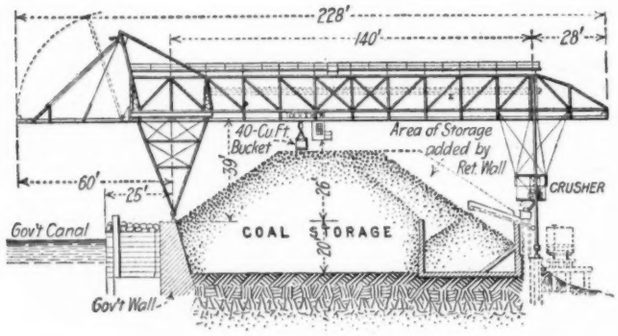

FIG. 7. TRAVELING BRIDGE OVER COAL STORAGE

connection. A water regulator on each boiler controls the feed. Exhaust steam from the feed pumps, forced-draft fan engines and the stoker cylinders is available for the heaters, all other auxiliaries being motor-driven.

Coal may be received by water or rail, the canal being on one side of the storage space and a spur track on the other. The storage area is about 270 ft. long and 140 ft. wide. giving an approximate capacity for 35,000 tons of coal. It will be served by a gantry traveling bridge, Fig. 7, with a cantilever on one end extending over the canal so that the traveling bucket of the bridge may unload the barges and dump the coal into storage or into the feeding hopper of a crusher attached to the framework of the bridge on the opposite side. The bridge extends over the railway track, so that the traveling bucket can be utilized to unload the cars and, if desired, dump the coal into the hopper feeding the crusher. A belt conveyor receives the coal from the crusher and by means of a cross-belt transfers it to a fine-coal storage space walled off from the general storage. By a Pawling & Harnischfeger monorail trolley hoist this coal is transferred to the overhead bunker in the boiler room. This is made of steel plates, concrete lined, and is equipped with bifurcated spouts leading to the stokers. The bucket holds one ton of coal, and the hourly capacity of the hoist is about 40 tons.

In the generating room there are two Allis-Chalmers steam turbo-generators rated at 6250 kv.-a. At 3600 r.p.m. the units generate three-phase 60-cycle current at 4000 volts. The exciter is mounted directly on the shaft. I-beam supports under the turbines resting on side walls eliminate concrete foundations or steel columns, so that the basement is clear for the condensers and auxiliaries. The former rest on steel columns, with short expansion joints between them and the turbines. The pumps are on the floor near the condensers, and light to each unit passes through a well left in the main floor midway between the turbines.

At full load, with steam at 250 lb. pressure and 125 deg. of superheat at the throttle, and a vacuum of 28 in., referred to a 30-in. barometer, the turbines are guaranteed to develop a kilowatt-hour on 12.7 lb. of steam, including that required to drive the exciter on the end of the shaft. This rate increases to 13 lb. at three-quarter load and to 13.9 lb. at half load. With 7000 sq.ft. of surface in a Wheeler condenser, this means that per unit of surface less than 1½ lb. of steam must be condensed. Per kilowatt of rating the surface reduces to 1.4 square feet.

An 18-in. circulating pump and the hurling-water pump, a combination air and condensate unit, are mounted on the same shaft and driven by a motor, the speed being 1500 r.p.m. Both pumps draw their water from the tailrace and discharge back to it, the condensate going to the feed-water heater. As the circulating water suction and discharge columns are nearly balanced, there is little work for the pump after the flow has been started.

An interesting feature is the absence of an atmospheric relief connection to the condenser. A specially designed balanced valve automatically controlled by the vacuum in the outlet of the turbine guards against excessive steam pressure in case of a drop in vacuum,

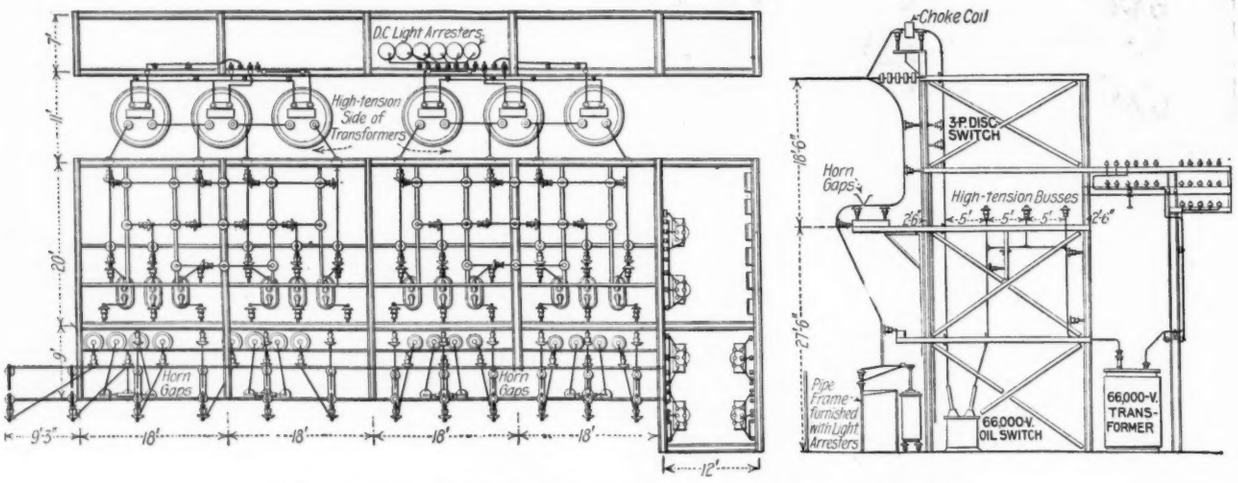

FIG. 8. PLAN AND SIDE ELEVATION OF OUTDOOR SUBSTATION

An interesting feature is the absence of an atmospheric relief connection to the condenser. A specially designed balanced valve automatically controlled by the vacuum in the outlet of the turbine guards against excessive steam pressure in case of a drop in vacuum,

by shutting off the steam supply to the turbine. Normally, the vacuum acting on a diaphragm against the action of a spring holds the steam valve open. If the vacuum should drop to a predetermined point, the spring closes the valve and shuts off the flow of steam. Before the turbine can be started, the air pump must create sufficient vacuum to open the automatic valve. The same arrangement was used in the new plant at Fremont, Ohio, described in the Oct. 24, 1916, issue of *Power*.

Each vertical-shaft single-runner hydraulic turbine, rated at 810 hp., drives a 650-kv.-a. 4000-volt three-phase generator with a 19-kw. exciter mounted at the top of the shaft. An oil-pressure governor, with a load-limiting device, maintains the speed at 90 r.p.m. The average head is 16 ft. Reference to Fig. 9 will show the general arrangement of these Allis-Chalmers units.

Current from the steam units is delivered to the main generating bus of the station. Disconnect switches divide this bus at the center so that if desired the station may be operated in two halves or the entire load handled from one side of the bus if it is desired to work on the other side. From the hydraulic units and the older equipment of the station the current is delivered to an auxiliary generator bus which has a cross-tie to either section of the main bus. All feeders are tied to the main bus and in addition have connection to an auxiliary feeder bus, so that any oil switch and the feeder-instrument equipment may be cut out for inspection or repair and the service in that particular line be maintained.

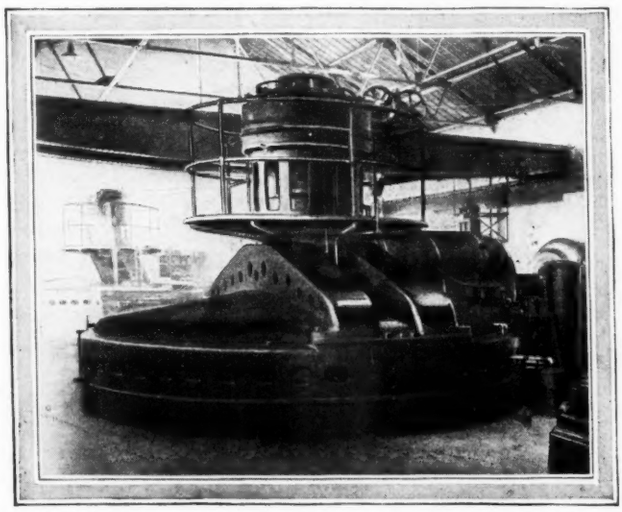

FIG. 9. ONE OF THE HYDRAULIC UNITS

All power feeders are three-phase three-wire; the lighting circuits are three-phase four-wire, the voltage between outers and neutral being 2300 volts. To supply Appleton the feeder circuits are taken off the main bus direct at 4000 volts. For transmission to Neenah the voltage is stepped up to 66,000 and to 33,000 for Kimberly.

All high-tension apparatus is located on a steel structure outside of the station, Fig. 8. First come the transformers, which are connected Y-delta, then the oil switches on the line side, which are solenoid-operated and protected by stud-type current transformers and outdoor relays. Baum-type disconnecting switches without horn gaps protect linemen from foreign current when at work on the structure. Choke coils and aluminum-cell arresters with horn gaps guard against lightning. In addition all low-tension arc and direct-current feeders have arrester equipment on the structure.

Station current for motors and lighting is drawn from the auxiliary generator bus, Y-delta transformers reducing the voltage to 440-220 for power and to 220-110 volts for lighting. The condenser circulating pumps have connections to the generator terminals, but a double-throw switch makes it possible to draw upon the auxiliary generator bus in case the unit is down. A feature of the 440-volt motor circuits is the use of oil switches in preference to the usual knife switch as a protection to the operator. This is a safety-first idea along the right lines, eliminating fuses and the possibilities of shock to station operators when manipulating the control equipment of the station auxiliaries.

Ten Rules for Foremen and Others

1. *Be Fair.*
   Have no favorites and no scapegoats. A foreman has to act as judge many times every day, therefore, he must be just.
2. *Make Few Promises and Keep Them.*
   A foreman must be exact in this particular. Sometimes a foreman forgets that his job requires a high standard of truth and honor.
3. *Don't Waste Anger. Use it.*
   Anger is the most valuable thing and should not be used carelessly. Keep your most forceful language for special occasions. Before a foreman can control others successfully he must control himself.
4. *Always Hear the Other Side.*
   Never blame a worker until he has been given a chance to give his point of view.
5. *Don't Hold Spite. Forgive.*
   When you have had to scold a worker, go to him later, in a friendly way. There should always be blue sky and sunshine after a storm.
6. *Never Show Discouragement.*
   Never let yourself be beaten. A foreman must have perseverance, and never say die.
7. *Notice Good Work as Well as Bad.*
   Mingle praise and blame. Let the workers see that you can appreciate as well as condemn.
8. *Watch for Aptitudes.*
   Take a keen human interest in your workers. Notice them. Study them. Put each one where he can do best.
9. *Be an Optimist.*
   Don't let your worries and troubles deform you into a pessimist. Inspire confidence. Put the "righto!" spirit into the works. Say—"Come along men, all together!".
10. *Take Your Full Share of the Blame.*
    This is the most difficult of all. It is heroic. But the foreman who can share both blame and praise with his workers will have discovered the secret of managing his men.—*The Central Station.*

The Significance of Load Graphs*

BY TERRELL CROFT

Load curves are given for different classes of electric-power-station loads, and these loads are combined to show the effect upon the load curves and load factor.

A LOAD graph, or as it is sometimes called a load curve, is a graphic record of the power loads which have been imposed on a station or on some electrical unit at all the different instants during a certain period of time. Figs. 1 to 15, which are based largely on data proposed by G. I. Rhodes, show examples of load curves. These graphs are usually plotted with the power values vertically and time plotted horizontally. The area included within the load curves, indicated by the shaded portions represents energy; that is, the product of power and time. Thus, in Fig. 1 the shaded portion of the graph is proportional to

$$Average\ Power \times Hours = 122{,}356 \times 24 = 2{,}937{,}538$$

kilowatt-hours

There are two general methods whereby the data for plotting load graphs may be obtained. In the first

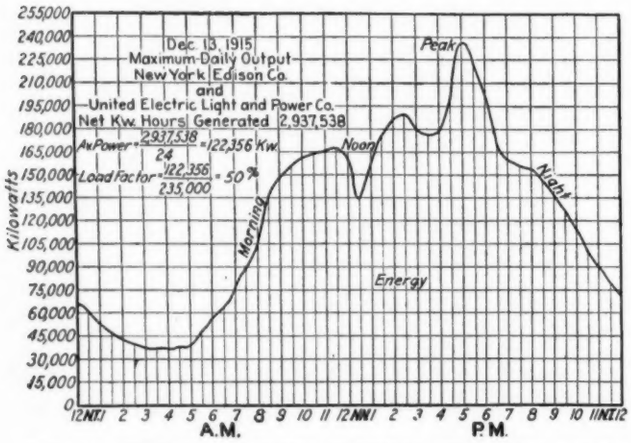

FIG. 1. NEW YORK CITY'S CENTRAL-STATIONS' LOAD CURVE ON DAY OF MAXIMUM OUTPUT, 1915

method, where graphic instruments are installed, the load imposed at any instant can readily be ascertained from the record made by the instrument. The record strip of a graphic wattmeter is its load graph. In the second method, where graphic instruments are not installed, the power values for plotting the graph may be read at equi-distant intervals from indicating instruments connected into the circuit. The frequency with which the readings should be taken will be determined to a large extent by the character of the load under consideration. If the load is subject to wide and continual fluxations, it may be desirable to take readings every minute or even every half-minute, but if the load is reasonably steady it will usually be sufficient to take a reading every 15 minutes.

Where an indicating wattmeter is available, the power values thus obtained from it may be plotted against time to obtain the graph. If no wattmeter is available but an ammeter and voltmeter are, then both instruments should be read simultaneously at the end of each time interval. The product of the current and voltage thus obtained will, on direct-current circuits, give the watts at the specified instant. On alternating-current circuits, unless the power factor happens to be 100 per cent., which is not likely to be the case, the product of the volts and amperes will not represent watts. Hence, with alternating-current circuits, it is inconvenient to obtain the power values unless an alternating-current wattmeter is used. The curve *C*, Fig. 2, was plotted from the following values:

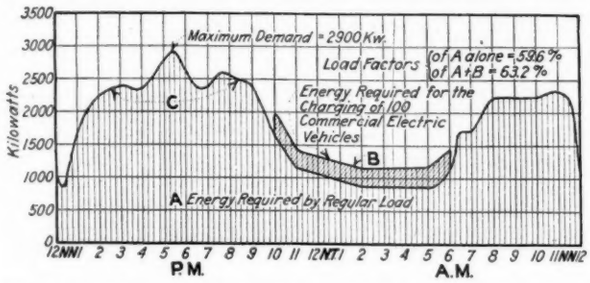
Maximum Demand = 2900 Kw.
Load Factors { of A alone = 59.6 % / of A+B = 63.2 %
Energy Required for the Charging of 100 Commercial Electric Vehicles
C
B
A Energy Required by Regular Load
Kilowatts
P.M.
A.M.

FIG. 2. EFFECT OF ELECTRIC-VEHICLE-CHARGING LOAD ON A CENTRAL-STATION LOAD CURVE

Time	Kilowatts	Time	Kilowatts
12:00 (Noon)	1,000	3:15	2,380
12:15	850	3:30	2,360
12:30	1,050	3:45	2,350
12:45	1,250	4:00	2,340
1:00	1,600	4:15	2,450
1:15	1,800	4:30	2,520
1:30	1,950	4:45	2,600
1:45	2,050	5:00	2,700
2:00	2,250	5:15	2,800
2:15	2,300	5:30	2,900
2:30	2,325	5:45	2,820
2:45	2,350	6:00	2,630
3:00	2,400	Etc.	Etc.

The importance of a load graph lies in the fact that it indicates at a glance the general character of the load that is being imposed and brings out the facts much more forcefully than will a couple of columns of figures. The higher the load factor (ratio of average load to maximum demand during a certain period of

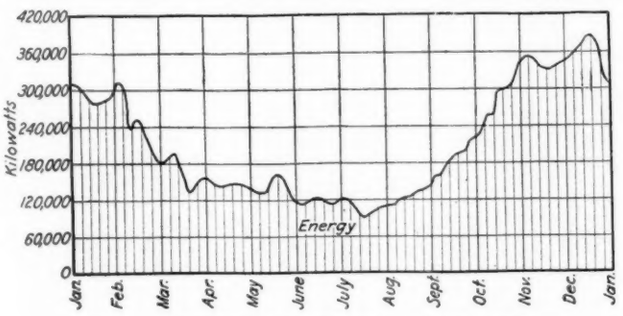

FIG. 3. ANNUAL OR YEARLY LOAD CURVE

time) the lower, in general, the unit cost of generating energy. Obviously, the more nearly the curve of a load approximates a horizontal line the nearer will the conditions be to the ideal. That is, to keep down the cost of energy production the "valleys" of a load graph should be filled in and the "peaks" reduced. An inspection of a load graph will indicate at just what hours

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of the day the "valleys" and the "peaks" occur, and with this information available, suitable measures may be taken to even up the load.

The unit for the ordinate values of a load graph is ordinarily a kilowatt. In certain instances it may, where constant-potential circuits are involved, be desirable to use the ampere; then these values can, on direct-current circuits, be translated into watts or kilowatts by multiplying by the voltage.

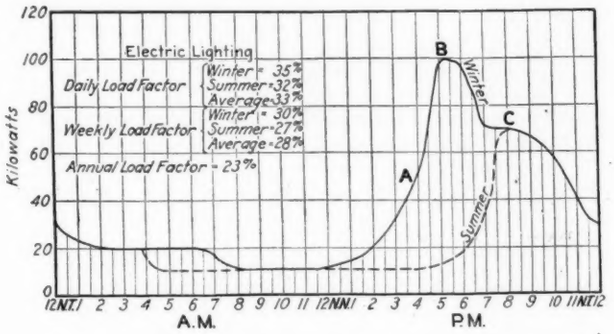


FIG. 4. TYPICAL 24-HOUR LOAD CURVE FOR AN ELECTRIC-LIGHTING LOAD

The period that should be comprehended by a load graph is a thing that local conditions must decide. Where plants operate 24 hours a day, it is usual to plot the curves relating thereto so that their horizontal lengths represent a 24-hour period. When a plant operates only 8 or 12 hours daily, then it is sufficient if the length of the curve represents only the 8- or 12-hour period. Most load graphs are plotted on a 24-hour basis as an examination of the accompanying illustrations will verify. Frequently it is desirable to plot graphs on a yearly basis, as illustrated in Figs. 3 and 14, so that the distribution of the energy expenditure over the entire year may be studied.

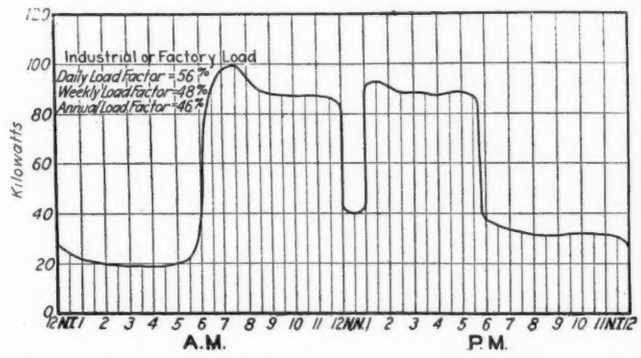


FIG. 5. TYPICAL 24-HOUR LOAD CURVE FOR INDUSTRIAL OR FACTORY LOAD

The load graph of a typical electric-lighting load in a town or city is shown in Fig. 4. Where there is little or no demand for energy for motors or railways, the power consumption will vary through the 24 hours approximately as diagramed in the illustration. The full-line graph indicates a typical winter-day power demand, while that which is dotted shows the demand during a typical summer day. The maximum demand occurs in the wintertime between 4 and 6 p.m., because at this time most of the stores and offices and many of the residences are using a maximum of light. A maximum peak for the year usually occurs in December (Fig. 1). In the summer the lighting peak is imposed in the evening about 8 o'clock, and it is of considerably lower value than the winter peak.

The minimum demand for lighting energy occurs between 9 a.m. and 2 p.m. in winter and between 4 a.m. and 5 p.m. in summer. A noticeable characteristic of lighting loads is the abruptness with which the energy consumption increases (from *A* to *B*, Fig. 4) in the evening and also the suddenness with which it decreases (from *B* to *C*, Fig. 4) after the shops and offices close in the evening. The load factors for typical electric-lighting loads of the general characteristics indicated in the curve of Fig. 4 are noted on the illustration. As there suggested, the annual load factor is about 23 per cent.

A typical graph for an industrial load is represented in Fig. 5. The load is a minimum during the hours when the industrial plant is not in operation. But the demand increases very abruptly at about 6 a.m. and attains the maximum for the day about 7 or 8 a.m. At the noon hour the graph drops almost vertically downward and rises again at 1 p.m., when the machines and lighting equipment are again put into service. It should be noted that the afternoon peak occurs shortly after 1 o'clock, but it is seldom as great as the morning peak. The power demands imposed by an industrial plant are about the same in winter as in summer. The annual load factor will be about 46 per cent.

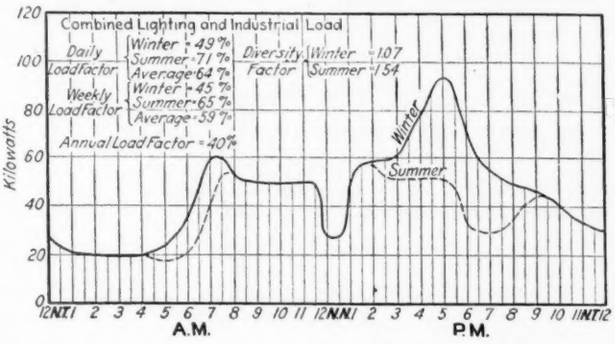


FIG. 6. TYPICAL 24-HOUR LOAD CURVE FOR COMBINED ELECTRIC-LIGHTING AND INDUSTRIAL LOAD

By combining a lighting and an industrial load on the same energy supply source, the resultant load imposed on the generating equipment will be of the character indicated in Fig. 6. Owing to the diversity of the demands between the loads of these two different types, there is a tendency toward smoothing out the

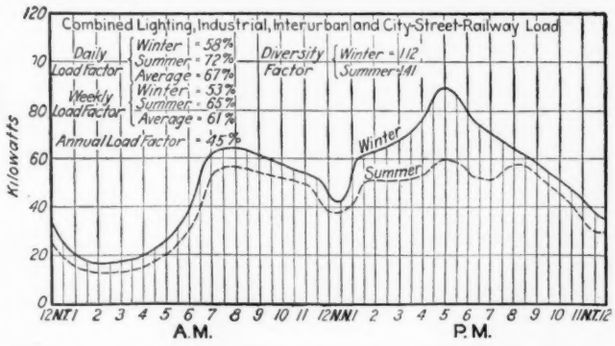


FIG. 7. LOAD CURVE FOR COMBINED LIGHTING, INDUSTRIAL, INTERURBAN AND CITY RAILWAY LOAD

hollows in the load curves, and the annual load factor for such a combined load is about 40 per cent., as against 23 per cent. for the uncombined lighting load of Fig. 4. Therefore it follows that a material economy in energy production results where loads of dissimilar characteristics can thus be consolidated.

A combination of lighting, industrial, interurban and street-railway loads will impose on the supplying equipment demands that will vary through the twenty-four

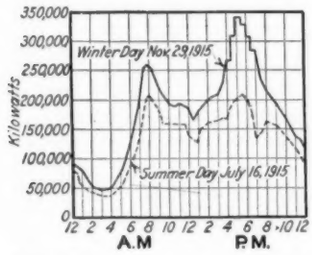


FIG. 8. LOAD CURVES FOR CHICAGO, ILL.

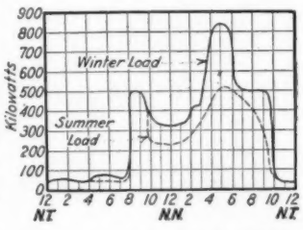


FIG. 9. OFFICE-BUILDING PLANT LOAD CURVE

hours of the day somewhat as outlined in Fig. 7. The annual load factor will be in the neighborhood of 45 per cent.

Load graphs for large cities are shown in Figs. 1 and 8. These have been plotted respectively for New York and Chicago from actual operating data. Both indicate the results that may be expected by combining loads of different characteristics on one supply system. The curve, Fig. 1, comprehends loads handled by two companies which operate in New York City—the New York Edison Co. and the United Electric Light and Power Co. The load factor is approximately 50 per cent. Fig.

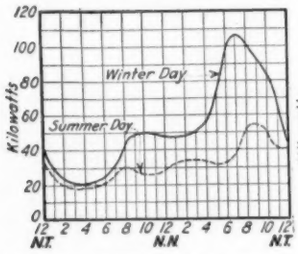


FIG. 10. HOTEL ISOLATED-PLANT LOAD CURVE

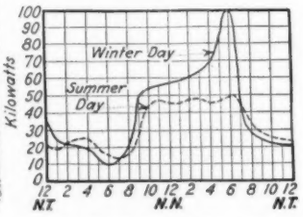


FIG. 11. DEPARTMENT-STORE PLANT LOAD CURVE

8 shows the total load for a typical summer and winter day, which the Commonwealth Edison Co. of Chicago, Ill., serves.

A load imposed on an office-building isolated plant will have the general characteristics graphed in Fig. 9. The peak at 8 a.m. is due, for the most part, to the energy taken by the electric elevators. The evening peak between 4 and 6 o'clock is due largely to the power required for lighting, but the elevator power also has its effect at this time.

A hotel isolated plant will usually have imposed on it a load that will vary with the time somewhat as outlined in Fig. 10. The peak, which occurs in the evening, is due, for the most part, to electric lighting, but the electric-elevator requirements usually add an appreciable share to the demand at this time.

A department-store isolated plant will have imposed on it a load of the typical properties plotted in Fig. 11. The peak occurs quite early in the evening, just about the time the store closes, and the demand drops off abruptly after closing time. A somewhat unusual feature of department-store loads is that at certain hours of the day the summer off-peak load may be greater than the load imposed at the same hours in the winter time.

How the addition of off-peak loads will improve the load factor is brought out by the curve, Fig. 2. The area

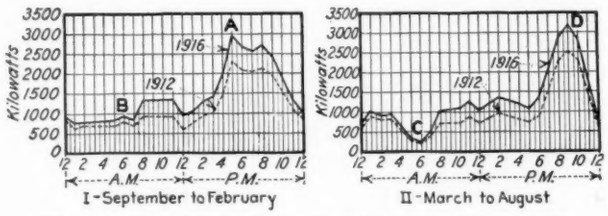


FIG. 12. WINTER AND SUMMER LOAD CURVES

A represents the energy required by the regular load on the plant in question, which operates in a city of approximately 100,000 inhabitants. The curve shows the conditions on Feb. 1, 1916. The load factor for load *A* is about 59.6 per cent. If the energy *B* required for the charging of 100 commercial electric vehicles be added during the "valley," the load factor is increased to 63.2 per cent. and a consequent reduction in energy-production cost will result.

A comparison of winter- and summer-load curves for a power station in a city of approximately 180,000 in-

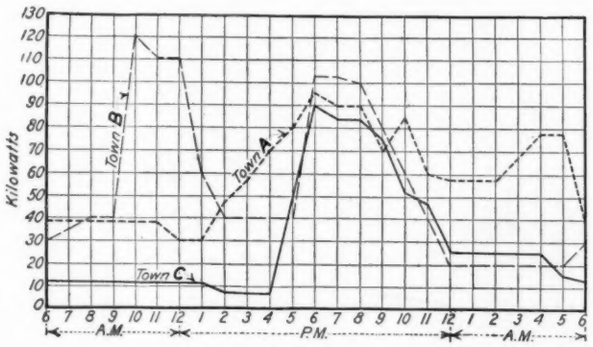


FIG. 13. LOAD CURVES FOR THREE SMALL TOWNS

habitants is given graphically in Fig. 12. This illustration also shows how, in the particular case under consideration, the load was increased during the period of four years (from 1912 to 1916).

The characteristic load graphs for small towns may vary considerably, as evidenced by the data of Fig. 13, wherein *A*, *B* and *C* are the curves for three different municipalities. This condition does not hold in the case

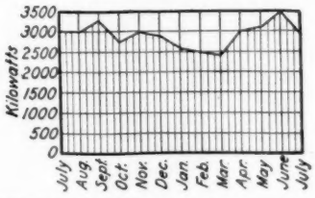


FIG. 14. CURVE INDICATING MONTHLY LOAD PEAKS

of the larger cities, because with them the load graphs for all usually exhibit similar characteristics. All three towns have approximately 4800 inhabitants each. In all the water-works pumps are electrically driven. In town *A* during the dry season the motors driving the compressors for the air-lift wells operate during the night

and also for several hours in the morning; that is, they operate from 9 p.m. to 6 a.m. There is a fair consumption of energy for the residential and commercial lighting, and there is a reasonably good street-lighting system.

The requirements of the town *B* are, in general, similar to those of *A*, but in *B* the pneumatic-lift water motors are operated from 9 a.m. until about 2 p.m. In town *C* the water-works pumps are operated between midnight and 4 a.m. In instances such as that just described, it might be possible to arrange with three different towns which are all fed from the same electricity supply system to operate their water-works motors at such times that their demands would not coincide. Where this can be arranged, the load factor of the combined load may be materially increased.

Annual load graphs may be plotted as suggested in Figs. 3 and 14, which will indicate how the consumption varies over the entire year. Frequently such graphs are plotted, as in Fig. 14, which indicate the maximum-load peak for each month rather than the variation of power demand throughout the period comprehended by the curve.

How a storage battery may be used for modifying the load demands imposed on generating equipment is illustrated by the load curves, Fig. 15. With no storage battery, the load imposed on the generating equipment is indicated by the graph *JKBCDEFGI* and the load factor is then rather low. But with a storage battery arranged for "off-peak" charging and "on-peak" discharging, the load imposed on the generating equipment takes the form represented by the graph *ABCDFGH* and the load factor would be relatively high.

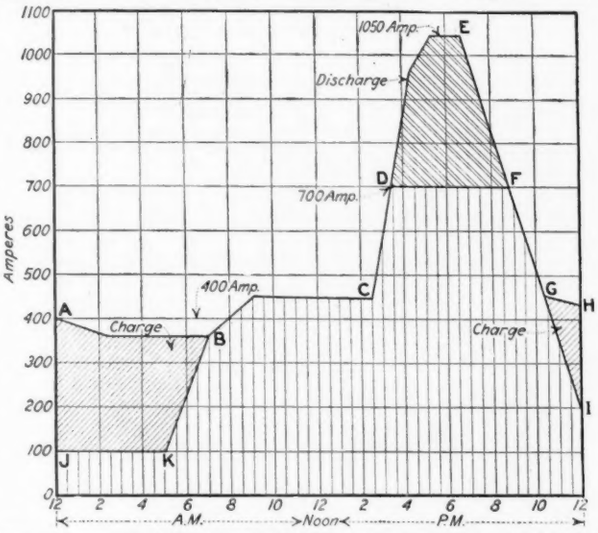


FIG. 15. EFFECTS OF STORAGE BATTERY IN IMPROVING LOAD FACTOR

Tom Hunter, Hoisting Engineer

BY WARREN O. ROGERS

Hunter tells of the early pioneering of No. 4 Calumet shaft, which is 8100 ft. deep, and of the circumstances leading to its discovery. The next day several types of hoisting units were seen and Hunter had something to say regarding simple and compound engines.

IT WAS but a short distance from the Superior compressor plant to No. 4 Calumet, and upon entering the engine room I was confronted with the largest hoisting engine I had ever seen. Larger ones were found later on, however. This hoist (Fig. 1) was a duplex tandem-compound condensing second-motion unit, with two 17-in. high- and two 34-in. low pressure cylinders, stroke 60-in. The winding drum was 25 ft. diameter, and it had a winding capacity of 5000 ft. of 1⅜-in. rope per layer, and the rope could be overlapped on the drum several times. The two skips weighed 6000 lb., and the capacity was 20,000 lb. of rock. The drum of the engine was fitted with a clutch that operated hydraulically, using a pressure of 250 lb. per sq.in. The clutch was on one side of the drum and the brake-band on the other; the brake was also hydraulically operated.

Steam pressure used for the hoist was at 150 lb. After exhausting from the high-pressure cylinder, the steam was reheated in a receiver before going to the low-pressure cylinder. The hoisting speed was 2000 and the lowering speed 2500 ft. per min. When the engine gets up to normal speed, the governor controls it to give about 2000 ft. per min. travel of the loaded skip. We were told that this shaft was 8100 ft. deep and ran at an angle of about 37½ degrees.

After looking the machine over, we left for the hotel, the afternoon being well spent. On the way Hunter enlightened me somewhat as to the history of No. 4 shaft.

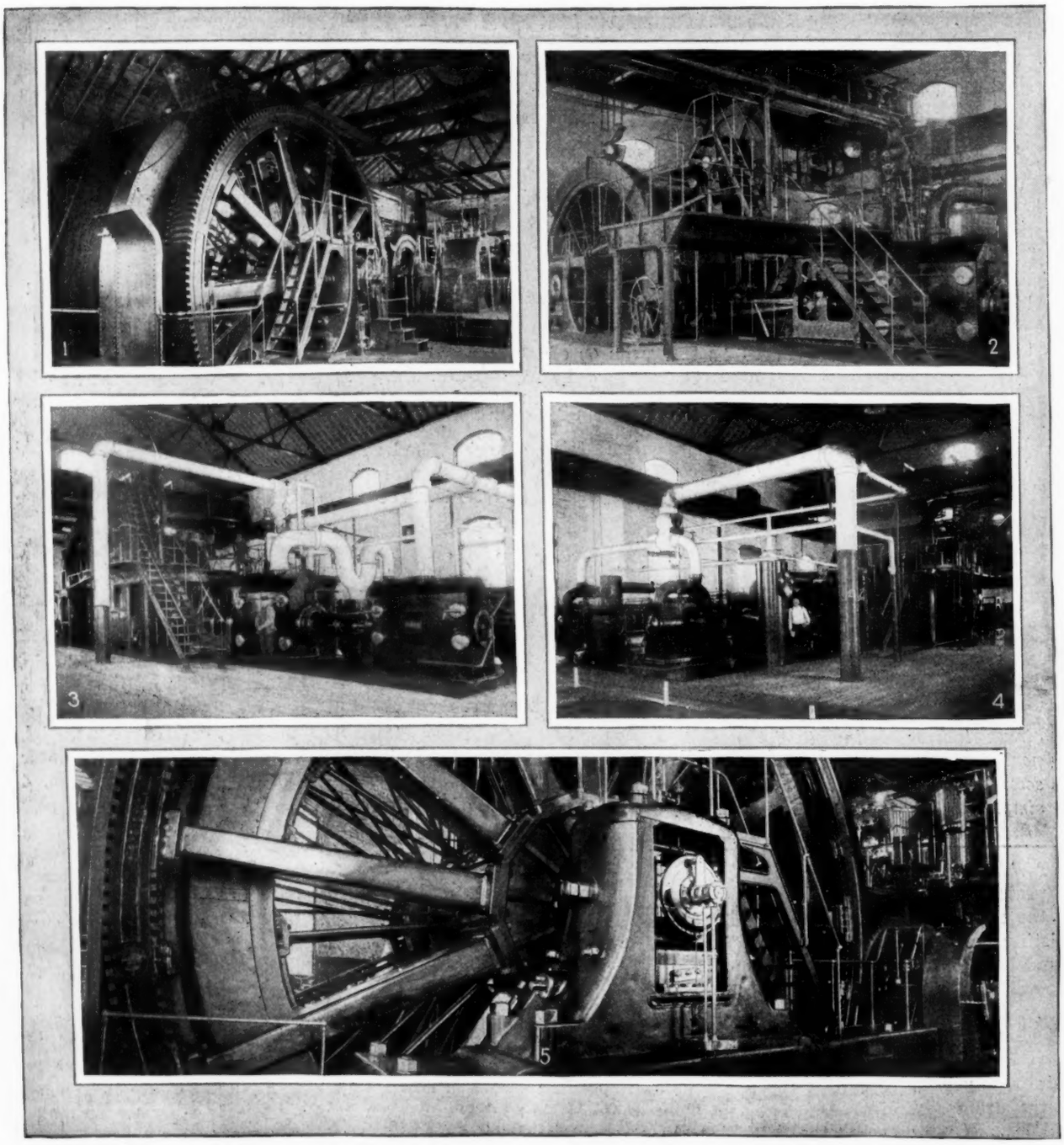
"The original Calumet mine," said he, "owes its discovery to a peculiar chance. From what can be obtained from such records as are available, it is gathered that long before white men hiked over the American continent, the native Indians were digging copper on Isle Royal, lying out in Lake Superior. off the northern shores of Keweenaw Peninsula. It is assumed that at the approach of winter they loaded their canoes with the copper they had accumulated and started for winter quarters farther south and that, instead of rounding the point of the peninsula, they landed about opposite to what is now the City of Calumet, where they were probably overtaken by early winter storms. We have seen for ourselves that they have snow here in mid-October.

"Anyhow, the Indians buried their copper for some reason or other, in a pit near where Calumet No. 1 shaft was located. This spot happened to be on the overhanging wall of the Calumet conglomerate. Years after, nobody knows how many, French explorers found copper down on the Ontonagon River, as I told you a few days ago, and it wasn't until 1858 that a fellow named Hulbert, who was surveying a state road, found the pile of copper that the Indians from Isle Royal had buried years before, and he mistook it for an old In-

dian copper mine. Naturally, he began looking about for further workings and came upon a large block of conglomerate that was infiltrated with copper. He decided that it had been lifted out of the ground by frost and was therefore close to its original position.

"Hulbert was foxy, and believing that he made a valuable discovery, he kept his mouth shut and went on with his surveying. He tried to buy the land where his find was located but could not, and so he got possession of a tract to the north, and what is now known as No. 4 Calumet, where we were this afternoon. Here he sank a shaft and struck copper-bearing rock. This was, as I recall, in 1864.

"Hulbert never got much out of his mine. He interested another man in the property, who with others, later acquired a controlling interest in Hulbert's mine and the latter finally traded his entire holdings in Calumet for an interest in the old Huron mine, which went to pieces later. Hulbert's former partners afterward bought land to the south of the Calumet shaft, and this property was known as the Hecla mine. These two properties were later combined.



FIGS. 1 TO 5. SOME OF THE HOISTING UNITS AT THE CALUMET & HECLA MINES

Fig. 1—A duplex tandem-compound condensing second-motion hoist at No. 4 Calumet. Fig. 2—Duplex-compound hoisting engine at No 6 Calumet. Fig. 3—A similar hoist at No. 15 Calumet. Fig. 4—Another large hoisting unit. Fig. 5—A 25-ft. diameter drum with a capacity of 5000 ft. of 1⅛-in. rope.

"You can well imagine that the operation of this mine was no cinch, and experts handed out more gloom by stating that the lode could not be made to pay. However, a fellow named Agassiz was sent to manage the mine, and with but little money and distrust on the part of those connected with the mines, within two years under his management things began to move and to show some signs of promise. Today, about 50 years later, you have had the privilege of visiting one of the most famous copper mines known."

At this point of Hunter's recital we reached the hotel, ready for a hearty supper. As it began to snow again, we went to bed early and were up in the morning ready to see whatever there was to be seen.

It was clear as we started for No. 6 Calumet. Here we were shown a duplex compound hoist, each side having 18 and 36 x 60-in. cylinders. The drum was 25 ft. diameter and had a winding capacity of 5000 ft. per layer of $1\frac{3}{8}$-in. rope. The empty skip weighed 12,000 lb., and the rock load was 20,000 lb. This hoist was of the second-motion type; that is, a gear on the engine crankshaft meshed with a gear rim on the drum. An idea of the size is given in Fig. 2. The unit ran condensing. The drum was fitted with a cylinder-operated clutch. No. 15 hoist, Fig. 3, was found to be similar to No. 6, except that the cylinders were 18 and 32 x 48-in. and the engine ran noncondensing. The next hoist, Fig. 4, was of similar size and of Corliss design.

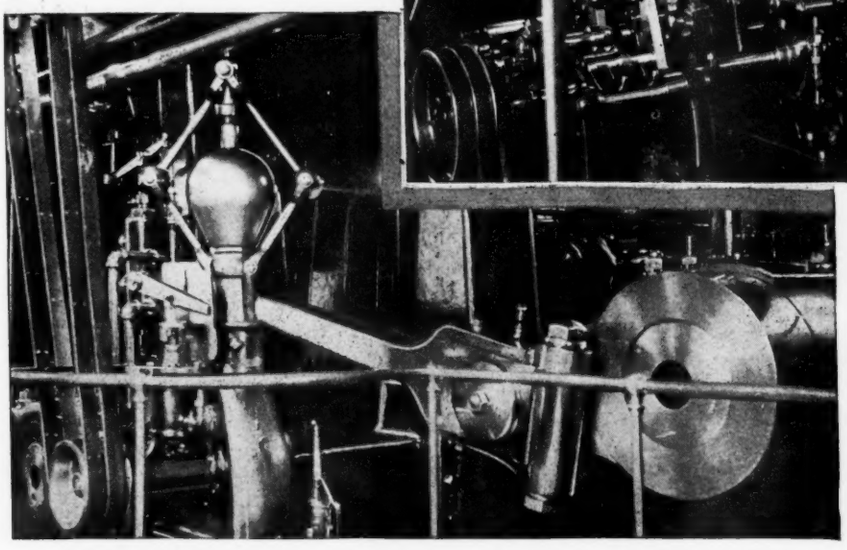


FIG. 6. GOVERNOR AND TWO OF THE CRANK-ROD CONNECTIONS

"I think the next hoists will give you a surprise," said Hunter, as we started toward No. 8 Hecla, and they did. Here we found the Leavitt-Morris type of engine; that is, the piston rods connected to one end of each rocker, the other end of which was connected to the main crankshaft, similar to the blowing engines at the Superior blowing plant. These engines, however, were triple expansion, with $20\frac{1}{8}$, $31\frac{3}{4}$ and 50 x 48 in. cylinders and each was rated at 2500 hp. at 87 r.p.m. and 160 lb. steam pressure when operated condensing. These engines are duplicates. The drums are 25 ft. in diameter and have a winding capacity of 5000 ft. of $1\frac{3}{8}$-in. rope. The skip weighs 12,000 lb., and the rock load is 15,000 lb. An idea of the size of the hoist can be gained from Fig. 5. As is the practice with the general Leavitt design of engine, the valves are operated from camshafts and cams. Fig. 7 shows the camshaft deck. The governor, Fig. 6, controls the point of cutoff of the steam valve by changing the position of the cams. These engines were of such finish that one could not help being impressed by the workmanship. Fig. 7 also shows the crank rods from two of the three rockers on the crankshaft. The drum is indirect; that is, the crankshaft carries a spur gear that meshes with the gear on the winding drum, as shown in Fig. 5. In Fig. 8 is shown a side view of the engine "Houghton," which was a duplicate of "Seneca," both engines being in the same house.

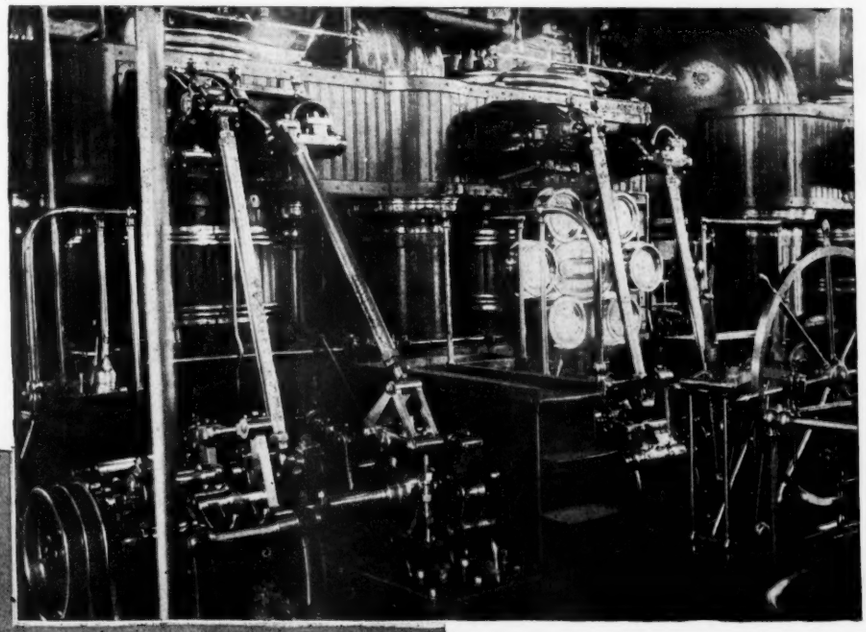


FIG. 7. A VIEW OF THE CAMSHAFT DECK

"I observe," said I, as we watched the operator handle the hoist, "that most of the large engines are compound or triple expansion. Why don't they use a simple twin engine?"

"Well, a compound engine has several advantages. It permits of a high range of expansion, decreases the cylinder condensation, also the clearance and leakage losses. Then, the crank effort is equalized and an increased economy in steam consumption is obtained."

"That seems all right, but don't the disadvantages counteract the advantages?"

"Sure they do to some extent. A compound engine will cost more to build because there are more parts than in a simple engine. Then it takes up more floor

space, and the upkeep is greater because of the wear and tear. It is more complicated, and the radiation losses are increased. In a simple engine there is but one cylinder, in which the steam is cut off at, say, one-quarter stroke and then expanded, owing to the cooling action of the steam and the reduction of pressure, until the point of exhaust is reached, when the steam escapes past the open exhaust valve to the atmosphere.

"A compound engine is one generally with two cylinders connected together so that the exhaust steam from one (high-pressure cylinder) is exhausted into the other (low-pressure cylinder) instead of to the atmosphere, as in the case of the simple engine. Generally, the low-pressure cylinder exhausts into a condenser. By this arrangement the steam expands to a low pressure with the least condensation losses. In a compound engine the steam is expanded partly in one cylinder and partly in the other, and as a consequence the temperature difference between the incoming and the outgoing steam in both cylinders is greatly reduced from what it would be if one cylinder expanded to the same final temperature. This results under ordinary conditions in about 20 to 25 per cent. less loss due to condensation. This means that a compound engine when operating under favorable conditions will perform about 25 per cent. more work with the same weight of steam than would be obtained with a single cylinder.

"You can see that to obtain the same power from the low-pressure cylinder with a lower pressure as from the high-pressure cylinder with its higher steam pressure, it is necessary to have a large low-pressure cylinder so as to give a large piston area for the low-pressure cylinder steam to work again. For instance, an engine having a 16-in. high-pressure cylinder and a 32-in. low-pressure cylinder would have areas of 201 and 804 sq.in. respectively. With, say, 160 lb. pressure there would be $201 \times 160 = 32{,}160$ lb. pressure exerted on the high-pressure piston. A piston having 804 sq.in. area would, with 40 lb. pressure, have $804 \times 40 = 32{,}160$ lb. exerted upon it, which is exactly the same as that of the high-pressure cylinder. The number of times the steam is to be expanded and the steam pressure govern the required size of the low-pressure cylinder. The work the engine is to do also has a bearing. For instance, the difference in the size of the cylinder may be greater with a steady load than if the engine is working with a fluctuating load of wide limit."

"What do you mean by number of times steam is expanded?"

"Perhaps this will make it clear: In order to determine the size of cylinders it is necessary to know the number of expansions the steam is to make. This is determined by dividing the absolute initial pressure by the terminal pressure, and the square root of the total expansion equals the ratio of the cylinders. Take a size of cylinder 16 and 32 mentioned awhile ago and using the same steam pressure, then $160 + 15 = 175$ lb. absolute initial pressure. Then assuming 1 lb. back pressure, there would be $15 + 1 = 16$ lb. and $175 \div 16 = 10.9$ total expansion. Then $\sqrt{10.9} = 3.3$, or a cylinder ratio of 3.3 to 1. This would be for a noncondensing engine.

"If the ratio of the low- and high-pressure cylinders of a compound engine were made too large, the steam would expand in it to less than atmospheric pressure, which would result in a loss. In such a case the indicator diagram would show a negative loop on the exhaust end."

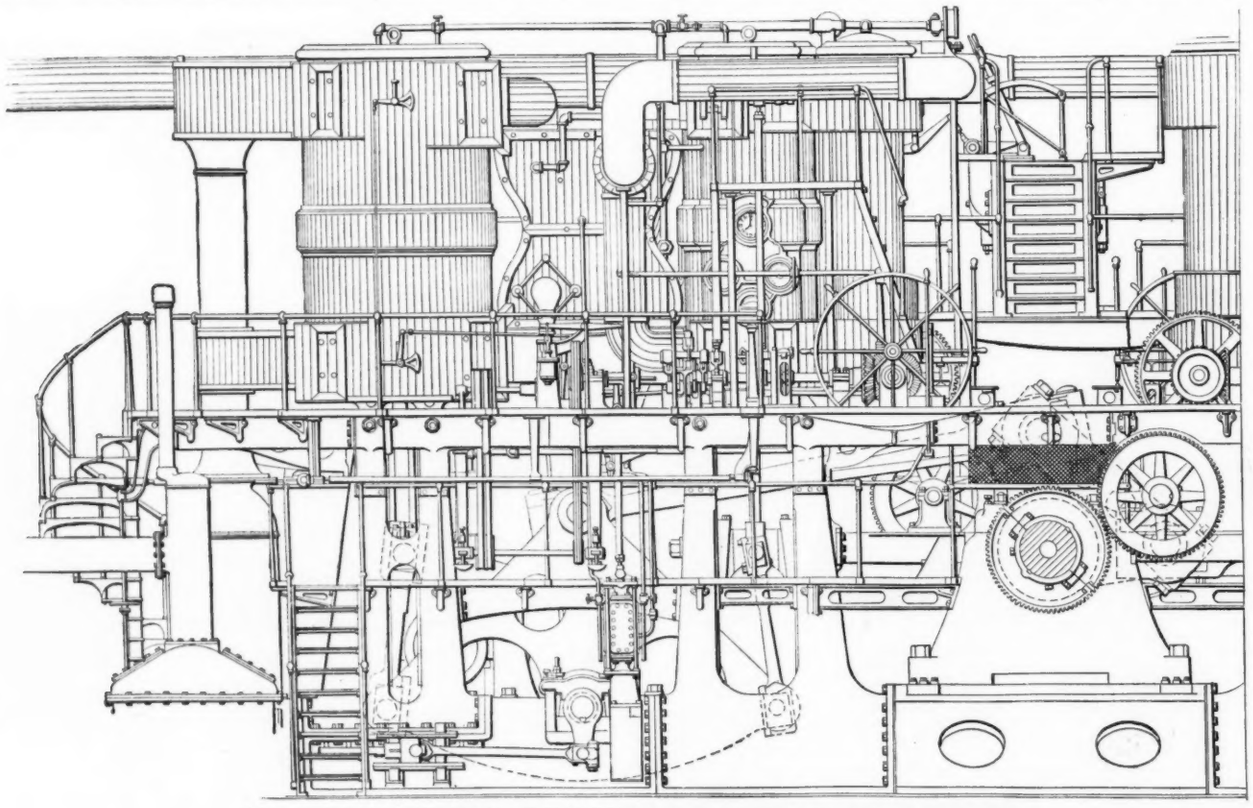


FIG. 8. SIDE ELEVATION OF HOUGHTON AND SENECA HOISTING ENGINES

Recording-Demand Watt-Hour Meter

With large power requirements it is common to fix the rate for the service by the time and duration of occurrence of the maximum demand as well as by the amount of this demand. To determine this maximum demand, a reliable demand meter giving a permanent graphic record is required.

Fig. 1 shows a combination recording-demand and watt-hour meter developed by the Westinghouse Electric and Manufacturing Co., East Pittsburgh, Penn., and known as their type RA recording-demand watt-hour meter. The total kilowatt-hours consumed are indicated on a four-counter dial *D*. The integrated demand over successive predetermined time intervals is recorded in permanent form on the record sheet *R*.

The measuring and recording elements are mechanically interconnected, consequently there are no electrical contacts to become inoperative. A high-grade clock mechanism *C*, having features that make not only for clock accuracy, but for reliability of continuous operation, is used to control the recording element. The kilowatt-hour measuring element is this company's standard type OA watt-hour meter with a special gear train.

Under load the gear train of the watt-hour meter advances the counters in the regular manner. At the same time the gear train causes the ink-carrying pen *P* to advance across the record paper in proportion to the

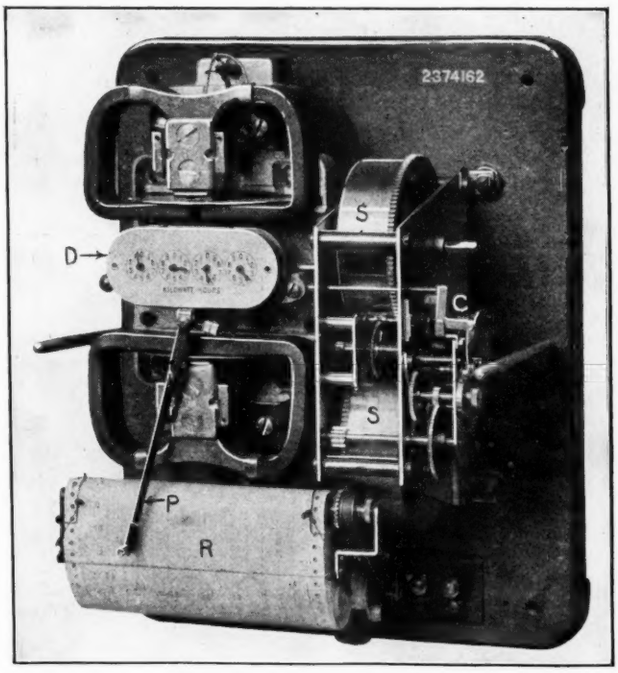


FIG. 1. RECORDING-DEMAND WATT-HOUR METER, WITH COVER REMOVED

energy registered. At the end of a predetermined time interval a stud on the reset wheel releases the pen gear from mesh with the gear train and a counterbalance weight returns the pen to zero, where it is again meshed with the gear train to repeat its advance during the next time interval. These meters are made for 15-, 30-, and 60-min. intervals; a meter made for one interval can readily be changed to operate at one of the other intervals.

Irrespective of the time interval of the meter, an operating spring, controlled by the clock, causes the paper to advance one-sixteenth inch every 15 min. Thus, if the meter is arranged to have 15-min. intervals, the paper advances just before the pen is reset, so that the pen makes a distinct and readily observed record of the maximum pen travel. If the meter is arranged to have 30-min. intervals, the paper advances one 15-min. space between periods, causing an offset mark on the chart

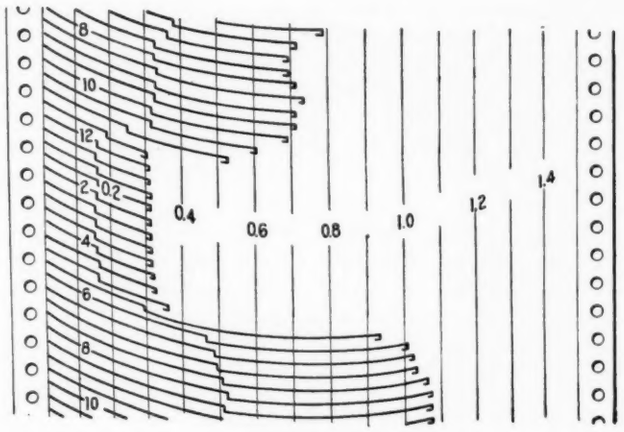


FIG. 2. THIRTY-MINUTE-INTERVAL RECORD OF MAXIMUM DEMAND METER

at the middle of the 30-min. interval, Fig. 2. This offset mark enables the reading of the integrated demand at 15-min. intervals, as well as at 30-min. periods. Similarly, if the reset wheel is arranged for 60-min. intervals, three offset marks indicate the 15-min. demands between each regular one-hour demand. The electrical measuring element is on its own supporting casting, therefore this element can be removed from the case as a unit without changing the calibration.

The paper-driving mechanism is a metal drum with pins that engage perforations in the record paper, driven through gearing by the operating springs *S*. The paper, which is furnished in 18-ft. rolls (36-days' supply), is held on a spindle and is wound off this on a drum by the driving mechanism.

I was told by a feller what knows, that a biler what exploded recently had been carried by one insurance company and they had dropped th' risk like a hot iron; it was refused by another and was then taken up by a third company. Now, if that is so, what protection does biler insurance give mor'n that it insures th' owner against loss of property in case th' dinged biler does explode? It don't protect him against damage suits due t' killed and injured people what had nothin' t' do with th' biler. I take it that most biler owners don't take this last proposition int' consideration until it is t' late.

Now yer Uncle Bill believes in biler inspection and insurance when it's carried on with common sense, but there ain't any sense for one company t' insure a biler after another has canceled th' risk because of th' condition it was in or because of th' abuse it was gittin'. It ain't honest business no matter haw yer look at it.—Bill B. Banger.

High Speed of Steam Turbines

By W. F. Schaphorst

One of the greatest objections advanced against the steam turbine in its early development was its high speed with the accompanying dangers. Station operators were the most ardent in their disapproval, and the idea of 750 or 1000 r.p.m. was looked upon with a great deal of distrust and fear. This was probably due to knowledge of the destruction wrought by the periodic flywheel explosion. It seemed doubtful that a wheel or rotating element, of built-up members, could be made in which the component parts could be held in place with a sufficient factor of safety to resist the centrifugal force due to the great circumferential speed—not only for the normal running speed, but also for such speeds as the turbine might develop when the governor should refuse to act.

Many exhaustive tests have been made by manufacturers, both here and abroad, with the result that turbine speeds for large units have been steadily increased and proved entirely satisfactory. This has resulted in a lower capital investment in the unit itself, as well as in the buildings and foundations.

Formulas for Centrifugal Force

When the formulas for centrifugal force are analyzed, it becomes apparent that the aforementioned fears were not solely due to ignorance, but were well based on the mathematical facts that the centrifugal force varies as the square of the circumferential velocity, or the centrifugal force tending to pull out the blades from their anchorages would equal $F = \frac{Wv^2}{gR}$, where

F = Centrifugal force;
R = Radius in feet, or distance from rotating axis to the center of gravity of the revolving body;
W = Weight of body in pounds;
N = Revolutions per minute;
n = Revolutions per second = $\frac{N}{60}$;
v = Linear velocity of the center of gravity of the body in feet per second;
g = 32.16, or acceleration constant due to gravity.

Since

$$v = \frac{2\pi RN}{60};$$

$$F = \frac{Wv^2}{gR} = \frac{WRN^2}{2933} = 0.0003410WRN^2 \text{ lb.}$$

Assuming a low-pressure wheel for a large turbogenerator to be 8 ft. outside diameter, turbine running 1800 r.p.m., blades 16 in. long and the weight of each blade 4 lb.

Then

W = 4 lb.
R = 3 ft., 4 in. = 3.33 ft.
N = 1800

and the centrifugal force per blade is $F = 0.000341WRN^2 = 0.000341 \times 4 \times 3.33 \times 1800^2 = 14{,}716.4688$ lb. This is the force tending to pull out each blade from its anchorage in the disk at 1800 r.p.m.

As the requirements for turbines of larger capacity became more urgent, it was necessary to increase the peripheral speeds. This involved new problems such as securing the blades and developing steel that could withstand the stresses due to the centrifugal force. It was common practice for turbines up to 5000-kw. capacity to run at 900 or 1200 r.p.m., which was at that time considered a high rotation speed. The introduction of 1800 r.p.m. for 25,000-kw. or larger units caused much comment and doubt among designing engineers as well as a large amount of skepticism on the part of operating engineers.

In order to satisfy both the owner and operating engineer, as well as the designing engineer, it is advisable to specify, when asking for bids for new machines, that the manufacturer agree to an overspeed test of 80 to 100 per cent. on the low-pressure wheels taken at random from the ones that are to go into the machine. Where this cannot be done, a sample wheel could be made up to approach as nearly as possible the conditions in the turbine wheel it represents, the selection of wheel to be made by the purchaser or his representative and the test witnessed by a representative of the purchaser.

Methods of Running the Test

The ideal test would be to submit the entire turbine to 80 or 100 per cent. overspeed test run. As this would be expensive and most likely impossible for the manufacturer, owing to lack of available steam, the following method is recommended, as it provides a way to obtain a speed test which will approach operating conditions:

The selected wheel is to be bolted to a spindle and inserted into a single-runner casing, which in turn is to be connected to a high-pressure steam main with only a shutoff valve between the steam supply and turbine. A direct-reading tachometer is to be connected to the shaft, and readings taken to verify the speed of the wheel being tested.

Doubtless some manufacturers would be entirely satisfied to subject their wheels to an 80 or 100 per cent. overspeed test if allowed to connect the disk to a motor shaft, as then there would only be the centrifugal force to distort the wheel, but this method does not approach operating conditions as there are no lateral stresses put upon the blades of the disk due to the steam action.

Before placing the wheel in the casing, it should be thoroughly inspected and marked, so that any deformations that may develop, laterally or diametrically, during the test can easily be detected and verified. Also, the condition and spacing of blades at the outer end should be checked up; that is, the distance between blades should be checked up before the test and after.

From the foregoing observations, both before and after the test, it can be ascertained if the method of holding the blades in the disk, shrouding the blades at the tips, the design of the wheel and general features are correct or safe to withstand operating conditions. If the tests mentioned leave no distortion in the wheels, then the turbine wheels are safe and need not give cause of fear to the operating engineer; for example, if it is assumed that the wheel having been tested was 8 ft. outside diameter, with 16-in. blades of 4 lb. each and having reached 3600 r.p.m. during test, or 100 per cent. overspeed for an 1800-r.p.m. turbine.

For the conditions given the circumferential velocity per minute of the outer edge of the turbine wheel for

the overspeed test would equal $V = 2\pi RN$, where

$R = \frac{8}{2} = 4$

$N = 3600$

$V = 2 \times 3.1416 \times 3600 \times 4 = 90477.8$ ft. per min., or 1507.97 ft. per sec., or 17.13 miles per minute.

The centrifugal force on a blade on the above wheel tending to pull it out would $= F = 0.000341 \times WRN^2$, where

$W = 4$

$R = 3$ ft. 4 in. $= 3.33$ ft.

$N = 3600$

Hence $F = 0.000341 \times 4 \times 3.33 \times 3600^2 = 58{,}865.875$ lb. pull per blade tending to pull it from its anchorage on the disk.

[The foregoing is a subject that is attracting considerable attention at the present time. *Power* invites the opinions of interested readers for publication, as it is understood that similar tests have already been run. —Editor.]

Commutator Truing Apparatus

Of course there are various methods employed in smoothing up commutators on rotary converters, motor-generator sets and turbo-generator collector rings. The following describes several ways of doing this work.

In one case a 4½ x 4-in. 10-hp. Westinghouse Junior engine is used. It is provided with four heavy caster wheels to facilitate moving it from one machine to another, as wanted. When the commutor of a machine requires turning up, the engine is moved into position and a 24-in. pulley is secured to the end of the generator shaft to carry the belt from the engine pulley, Fig. 1.

Steam is supplied to the engine through a rubber hose that is connected to a steam pipe in the basement.

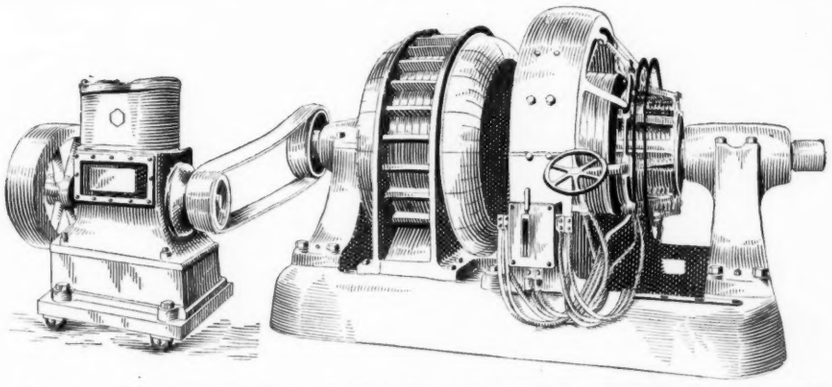


FIG. 1. SMALL STEAM ENGINE DRIVING MOTOR-GENERATOR SET FOR TURNING COMMUTATOR AND COLLECTOR RINGS

The exhaust steam is conducted, by means of a hose, out through a window. The speed of the machine is governed by throttling the steam at the engine. A moderate speed is used for small rings, and for the larger commutators a slower speed is maintained.

When it becomes necessary to turn down the commutator of some designs of turbo-generator exciters, it is quite an undertaking to remove the armature, place it in a lathe, put the commutator in shape and then assemble the machine again. This job will require about two days.

In order to do the work with the least expenditure of labor and time, one engineer devised a turning arrangement that could be secured to one of the brush-holders and turn the commutator without making any changes on the machine other than lifting the brushes and reversing the position of the one brush-holder that supports the tool carriage.

The design of the machine was such that the outer bearing of the armature shaft was supported by four arms which terminated in a ring that belted to the generator casing. The double commutator was fitted with a central steel shrunk ring. These conditions

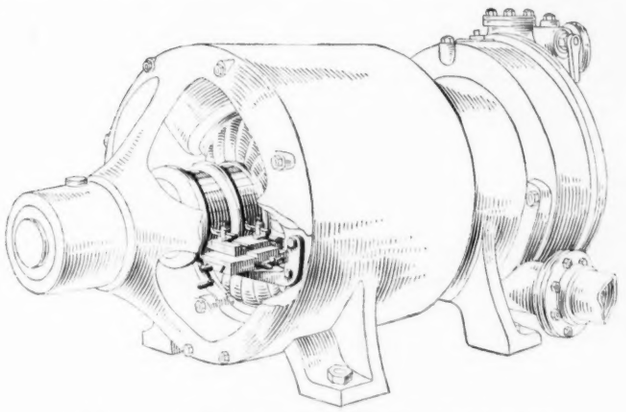


FIG. 2. COMMUTATOR-TURNING DEVICE ON TURBO-GENERATOR

made the commutator more difficult to turn while in the machine. If the tool carriage was belted to the brush-holder with it in its normal condition, the cutting tools would be brought too high above the center of the commutator. Therefore, in order to bring them opposite the center line it was necessary to reverse the brush-holder to an upside-down position. The general arrangement of the turning tool and brush-holder is shown in Fig. 2. When turning the commutator, just enough steam is turned into the turbine to revolve it at about 150 r.p.m. The cutting tools used are diamond-pointed, ground with a slightly flat end to avoid digging into and grooving the copper segments. As copper is a difficult metal to work, some care is necessary in order to obtain a finished job. With this arrangement one man can turn the commutator in two hours. An arrangement for grinding the collector rings on a turbo-generator, etc., is shown in Fig. 3. This consists of a frame made of 2 x 3-in. stock. An extension piece A is secured in place by two cross-irons and bolted securely. This headpiece forms a bed for the emery-wheel carriage, the body of which is bolted in place between the headpieces A and B. The emery-wheel carriage is moved endwise by means of a threaded rod that screws into a thread hole in the bottom of the carriage body. A cross movement for the bearing body is obtained in a like manner. In fact, the lengthwise and crosswise movement is practically the same as the cross feeding is accomplished on the cutting tool of a lathe.

When the collector rings require regrinding, as they do frequently because of the flat surface[1] that forms opposite the wire connection, the rig is placed in position and an iron brace is bolted to the bearing cap by one of the cap bolts. This brings the 7-in. emery wheel close to the collector rings, and further adjustment is had by the hand-feed screw. On the base of the frame a ¼-hp. motor is secured and belted to the 12-in. diameter, 12-in. wide, flat-face pulley on the emery-wheel

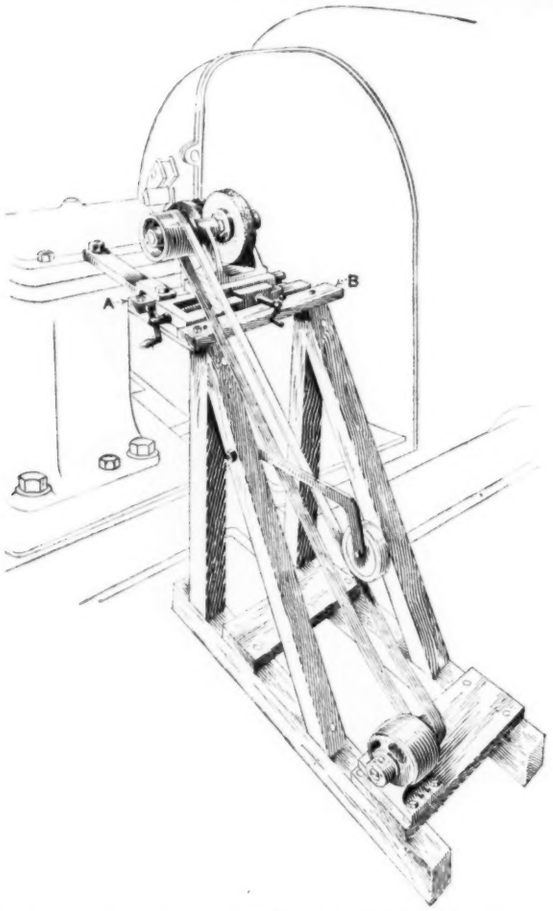


FIG. 3. RIG FOR GRINDING COLLECTOR RINGS

shaft. In order to provide for a back-and-forth movement of the emery wheel, an idler pulley is used to take up the slack of the belt. The details of the device as applied to the generator are shown in Fig. 3.

Any one of these three devices or a modification can be made by the engineer of a plant where necessity arises.

Good Boilers Badly Treated

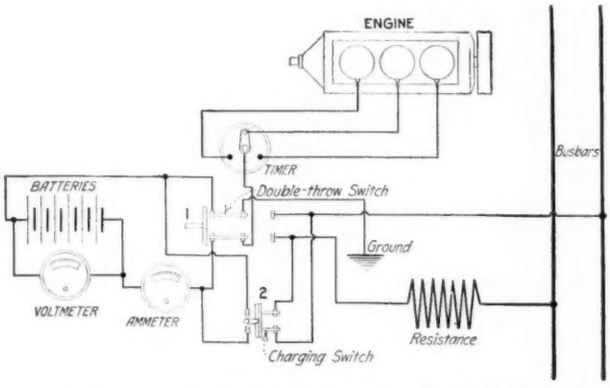
BY D. M. MEDCALF

No matter how rigid the inspection, it is not a guarantee that the boiler will not explode, because it depends largely upon the care and attention it receives when in operation. Quite recently I was requested to make an examination of two 66-in. x 16-ft. horizontal return-tubular boilers that had been seriously damaged. The boilers had been built from an approved design and inspected during construction; the shell plates had been carefully examined and passed. The workmanship was observed during the entire construction, and upon completion certificates were issued in the regular way, but after these boilers had been in service six months each developed a bag on the sheet directly over the fire extending 4 in. down 3 ft. wide and 5 ft. long, and on account of their being practically new, the owner claimed that the cause was poor material and workmanship, and I was called upon to act as referee.

When I visited the plant I requested that the manhead under the tubes be removed. Immediately the light was flashed on the interior of the boiler, it was quite apparent what had caused the trouble. The water that lay in the depression and the tubes and shell as far as could be seen were coated with oil. It was a difficult matter to convince the owners that oil had caused the trouble for it was a new plant and oil, they claimed, could not get into the boiler because there was an expensive oil separator in the exhaust line from the feed pump, which was the only steam line returning its condensation to the boilers. A further examination showed the oil separator to be quite clean, but beyond the outlet a handful of grease was collected and formed the conclusive evidence that they themselves were to blame, and not the manufacturer, who made the boilers to comply fully with the requirements of the law. The repairs cost about $2500.

Ignition System Wirings

In a small electric-lighting installation driven by a three cylinder gas engine it was desired to use batteries for ignition in starting the engine and then switch over to the current being generated to furnish current for ignition. The wiring was arranged as shown. Switch 1 is a double-pole double-throw, and when thrown to the left the current from the batteries is connected to the timer, and when thrown to the right



WIRING DIAGRAM FOR IGNITION FROM TWO SOURCES

the current from the generator goes to the timer or distributor, and at the same time the batteries may be charged by closing switch 2 if they are low. The current is generated at 110 volts, and a resistance is placed in the line to the ignition circuit to step it down to the proper voltage. The two wires lead to the distributor only, and then one line is grounded in the engine frame and the other goes to the igniters in the usual manner.

[1] In the plant where this device is used the collector rings wear flat opposite the wire connection. This may be due to a faulty connection that causes excessive heating at this point. Inquiry does not show that this is the result in general practice. Other operators may have had similar conditions. If so, what causes them?—Editor.

Automatic Stoker-Regulating Device

By H. B. McDermid

The layout of a large, steam-driven station for the generation of power has within its scope many interesting details. In one such station housing three 20,000-kw. steam-turbine units, with five boilers now burning a total of 500 tons of coal per 24 hours, perhaps none is more noteworthy than the method used to regulate the furnace fires. The burning of such a large tonnage of fuel with but a few firemen becomes quite a problem; what it will be when the quota of boilers now contracted for is put into service can better be imagined than described. There will be twelve boilers, burning at the present rates some 1500 tons of bituminous coal per day, with turbines enough to consume all the steam that can be generated at 275 lb. pressure with 275 deg. superheat. The next turbine to be installed will be of 35,000-kw. capacity.

To produce the necessary draft for rapid combustion without abnormal expense for high stacks, forced draft is used, the air being forced through the fires by large turbine-driven fans. When a call is made for more steam, a damper regulating the air blast (which is maintained under constant pressure) is opened manually by the fireman in charge, thus admitting more air to the fires. This increased pressure under the grates automatically speeds up the stoker through a device here described.

The stokers are now driven by small vertical steam engines, which are soon to be superseded by steam turbines in the hope of reducing upkeep costs, but as the same system of speed regulation can be used for both, the same automatic device can be used for either type of drive.

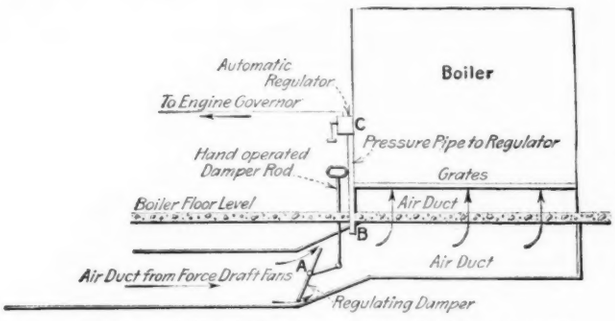


FIG. 1. AIR DUCT AND REGULATING DAMPER

From the forced-draft fans the air is distributed through large ducts to the various boilers, there being two stokers for each boiler. As the fans run at constant speed, a regulating damper is placed in each duct leading to a stoker. A 1-in. pipe is led to the stoker speed-regulating device through the duct walls on the stoker side of the damper so that it is under the same pressure as the furnace draft. The regulator pressure is received by an oil-sealed pressure cup, Fig. 2, and is transmitted through a balanced system of levers to the steam throttle of the engine stoker governor, admitting more or less steam as the load requires. In Fig. 1 is shown one of the air ducts beneath the boiler-room floor and the stoker grates, with the control damper at *A* and the regulator-pressure pipe at *B* leading to the regulator *C*. From *C* the pressure is transmitted to the engine or turbine governor, thus regulating the speed of the stoker drive to conform with the load requirements.

In Fig. 2 the pressure pipe *B* is shown discharging into the pressure cup *D*, which is closed at the bottom by the oil seal. If an increased load comes on, the fireman opens the damper *A*, Fig. 1, to increase the draft to the fires, which raises the pressure cup *D*, and this movement swings the bell crank *E* to the left and

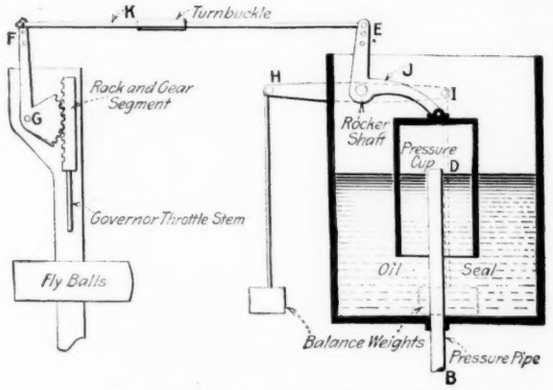


FIG. 2. DETAILS OF PRESSURE REGULATING CUP

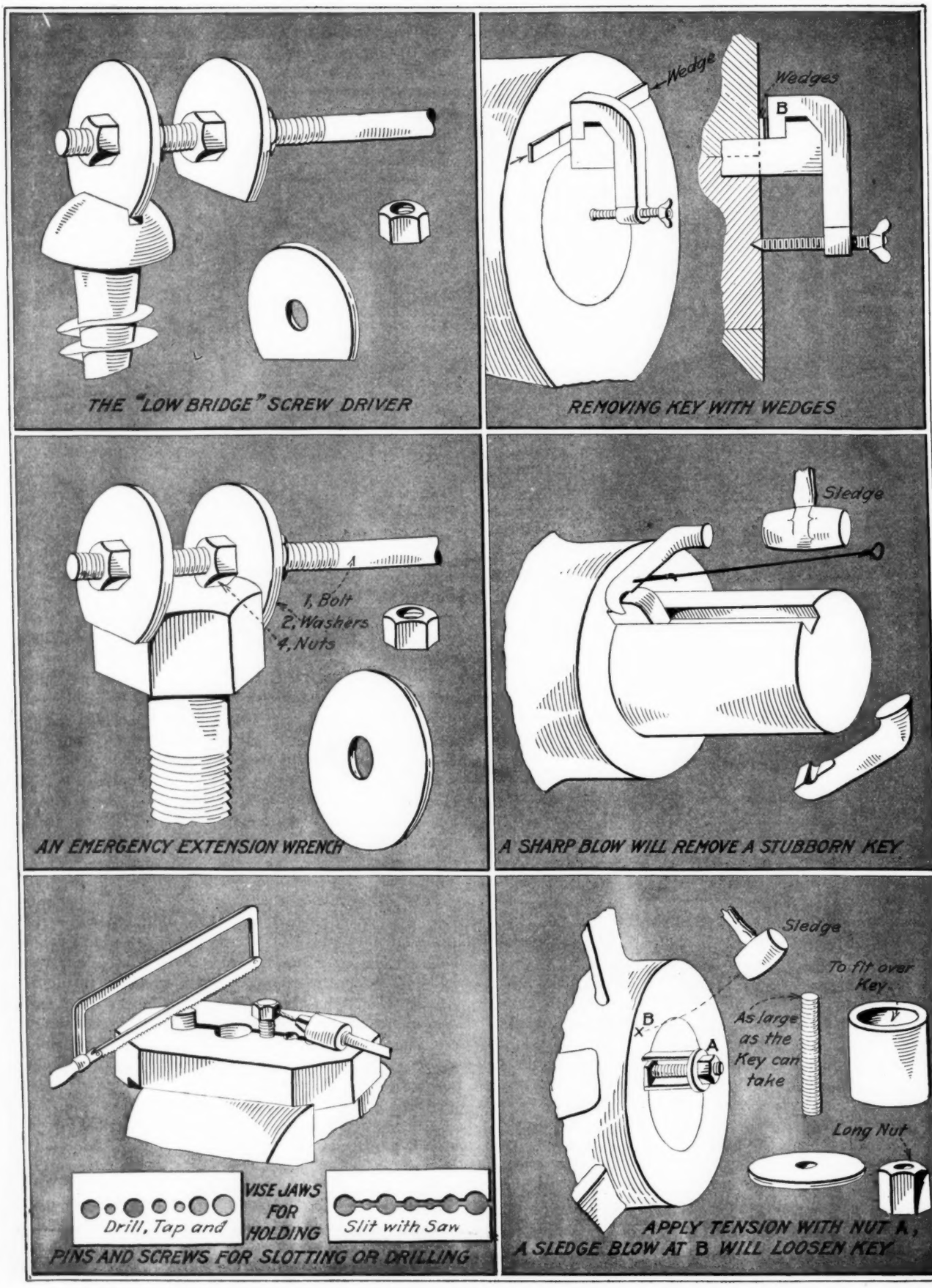
through the lever *F* and rack-and-gear segment *G*; the governor throttle is raised, thus increasing the engine speed and driving the stoker faster. When the load drops, the cycle is reversed, resulting in less fuel being fed to the fires by the stokers. The levers *H* and *I*, extending in opposite directions from the rocker-shaft, carry balance weights which can be adjusted so as to keep the system in balance. Both levers *E* and *F* have several holes, so that their leverage relations can be easily changed. All levers are fastened to their fulcrum shafts by setscrews, so that their relative angles can be quickly changed; the reach rod is provided with a turnbuckle *K*, so its length is adjustable. Thus any delicacy of adjustment desired can be easily obtained. The rack-and-gear segment at *G* is carried on and housed by the sliding head operated by the governor flyballs, so that in no case does the flyball element interfere with the speed adjustment made by the variation in pressure.

Supposing the pressure system has opened the governor throttle valve; it is obvious that the balls must fly farther apart to force the valve shut; therefore the engine must run faster. In the opposite case the valve can be closed by a lower speed, so that in either case within its range the pressure system controls the speed.

In practice it has been found possible to meet very heavy changes in load in a manner entirely satisfactory. In one instance the load was raised from 9000 to 20,000 kw., an increase of 11,000 kw., in a period of 15 minutes, without any perceptible variation in steam pressure being shown by a recording gage. The system has been in operation for several months and bids fair to meet all requirements.

A water column should be blown down at least twice a day, to remove any sediment that may have lodged in the pipes and to test the freedom of the connections by noting how rapidly the water returns to its original height in the gage-glass.

Kinks from an Engineer's Notebook



Editorials

A Progressive Step

DEMOCRACY is the success it is chiefly because of the free exchange of ideas it fosters. Because of the truth of this as applied to any organization, the recent convention of the National Association of Stationary Engineers was favorably unlike other conventions of that body. At the convention in Minneapolis last year a resolution was adopted, setting aside several hours of the Wednesday and Thursday sessions for welfare talks by delegates. Heretofore the convention has been so engulfed in the routine of reports of various committees that whenever ideas were in the minds of delegates awaiting expression, they never came forth unless they were germane to the business then before the assembly. This had the undesirable effect of fostering only passive interest except among officers and committeemen.

With the introduction of the welfare talks this year, many of these undesirable conditions passed away. The convention was not only unusually democratic—it was more. It was in some respects a revelation. There arose to their feet men whose qualities as leaders and potential powers for good may have been known locally, but never before were revealed to the national body as a whole. The welfare talks will have done a worthwhile good if they do no more than discover the kind of timber that will make of the association a stronger structure in these days, when efficiency and industrial organization coldly weed out the unfit.

To expedite the welfare sessions, a committee will be appointed by John Wickert, the new president. This committee will doubtless be charged with the duties of making available to the convention papers on engineering subjects and discussion tending toward the general welfare of the association. While the appointment of this committee is a commendable move, it should be borne in mind that to prevent the welfare talks being a total failure, the committee must do a minimum of work, leaving the talks to the delegates as a body.

Transportation Needs

CONGRESS has voted appropriations unstintingly, and the Government, through the Shipping Board, is exerting every effort toward the building of ships to combat the submarine losses and supply the needs of the Allies. This is as it should be; but it is also imperative that the land-transportation facilities be strengthened in every way possible to relieve the economic situation at home.

It is true that much has been accomplished through the operation of the Transportation and the Priority Boards, but there is still admittedly a marked shortage of freight cars. Great numbers are needed for the transportation of war materials and to supply the army camps, and are thus diverted from the normal channels of domestic needs. The supply of certain commodities appears to be sufficient to meet the demand if only they could be shipped to the markets. This is particularly true of coal. One large central station in the heart of the soft-coal district is reported to have notified its customers that unless it can secure sufficient coal, they will have to take turns in being without power one day a week. Yet there is said, on best authority, to be no shortage of supply at the mines.

With the limitations placed on the railroads in the last few years and the difficulty of increasing their capital, it is hardly to be expected that they will make any great expenditure for additional freight cars. Obviously, if the situation is to be relieved the Government must do it, just as it is doing in the case of shipping.

This proposition was the subject of spirited discussion at the recent Chamber of Commerce convention at Atlantic City, one side contending that other factors, such as lack of adequate terminal facilities and the practice of holding loaded cars, were equally responsible with the car shortage and that it would be presumptuous to make any recommendations unless preceded by careful study. The other side contended that the urgency demanded prompt relief.

With the Government happily taking steps to prevent speculative hoarding of necessities and having practically taken over the operation of railroads for the period of the war, a few million spent on transportation facilities would reap a big return in relieving the economic situation at home.

Fires Caused by Defective Electrical Installations

PREVIOUS to 1897 there were no prescribed standards for installing electric wiring and equipment, consequently installations were made according to the individual's own idea as to quality of workmanship, materials, etc., and in most cases this was done with little regard to the fire hazard. Not only was this true on the receiving end of the circuit, but in many cases in the power plant the installations were inferior in quality. In consequence of such practices fires due to electrical installations were quite prevalent and the belief became widespread that not only an electrical power plant but any electrical installation was particularly liable to suffer from conflagrations, and the truth of this belief was borne out, in the early days of the industry, by the number of fires that were caused by defective electrical installations.

However, in 1897, through the efforts of various insurance, electrical, architectural and allied interests, certain prescribed standards for electric wiring and equipment were drawn up and adopted, which today are known as the National Board of Fire Underwriters' Code. Since the promulgation of this code and its more general enforcement by electrical inspectors, the number of fires due to the presence of electric circuits both inside and outside the power plant have gradually de-

creased until at the present time serious fires in power plants rarely occur. The opinion rendered by a committee of the Ohio Electric Light Association, after an investigation covering a period of five years in the State of Ohio, was that the number of serious fires in central stations was trivial, and that these stations should be considered a preferred risk by the insurance companies, which up to the present time have taken a somewhat different view. On the other hand, in many industries and buildings used for various purposes, the introduction of electric lighting has made them a preferred risk over that when oil or gas lighting was used.

Although improved workmanship has gone a long way toward preventing fires of electrical origin, the vast improvement that has been made in electrical fittings during the last twenty years has also been a dominant factor. These fittings have been brought to such a state of perfection that if properly utilized, combined with good workmanship, fires due to the presence of electric circuits should be something of the past.

However, these fires do occasionally occur, owing to overloading the circuits, poor insulation, loose or poor connections, lack of proper protection and the absence of grounding the conduit on metal molding when used, etc. Although specifically required by the code, there has been a tendency to neglect grounding metal parts, no doubt with disastrous results more times than can be accounted for. Another serious practice is overfusing and overloading circuits, which is one of the most dangerous, not only as a fire hazard, but also to those who have to work around them. This practice is one that is very hard for inspectors to guard against, because overloading a circuit is generally cumulative. When the circuit is first installed, it is loaded within its capacity and properly fused, but is gradually overloaded by adding new devices after being put in service.

CARNEGIE INSTITUTE OF TECHNOLOGY

SCHENLEY PARK PITTSBURGH

September 15 1917

Mr.Fred.R.Low,
Editor of Power
New York City:-

My dear Mr.Low:-

In former days, when the reciprocating engine was the prime mover for power generation, we used to read in your columns about accidents and wrecks. Very often you would send a special reporter to the scene of the accident to have him investigate the causes of the wreck. And many were the readers of power who profited by the study of these reports, because they made us more careful in the design and in the operation of engines.

But matters have changed. Now that the steam turbine is the prime mover for power generation, we read nothing about accidents and wrecks. Not that accidents and wrecks have stopped happening. Quite on the contrary. I know of a turbine being wrecked in the plant of the National Tube Co. McKeesport. Then there is the turboblower at the Woodward Iron Co. Then there are two turbines at the Republic Steel Works in Youngstown. And at the occasion of a trip to Newark,N.J. a few days ago, I was told that two of the largest turbines in the country had been lost at a Newark Central Station. Now would it be asking too much to have you tell me, why we read nothing in your paper about these accidents. I assure you that we teachers and students of mechanical engineering would learn a great deal from detailed reports on accidents, and that we would be more careful about design and operation of turbines, if we knew just what caused these accidents to happen.

And would it be asking too much to publish this letter, together with your reply, in the columns of "Power"? This latter request is brought about by the remarks of several engineer-friends of mine who have commented on the difference between now and then and who will certainly be interested in knowing why the policy of careful investigation and publication of accidents to prime movers was changed , when the type of prime mover was changed.

With most sincere personal regards,

yours very truly,

W. Trinks

Professor of Mechanical Engineering

POWER

10th Avenue at 36th Street, New York, N.Y.

Prof. W. Trinks,
Dept. of Mechanical Engineering,
Carnegie Institute of Technology,
Schenley Park,
Pittsburgh, Penn.

Sept. 18, 1917.

Dear Professor:

In reply to yours of the 15th. There has been no change in our attitude toward the reporting of accidents to power plant machinery. We still believe that our readers are interested in knowing that accidents have occurred, and how they occurred, and that one of the best ways that they can be assisted in guarding against similar mishaps in their own work is to thoroughly understand the cause, manner and consequences of those which have happened to the other fellow.

When a big reciprocating engine ran away and strewed its flywheel over the neighborhood there was no dodging the fact that something had happened. We could usually learn of it and get a man there before they got the debris swept up and the door locked. If they refused, as they sometimes did, to let us investigate, we announced the accident, told what we knew about it and said that particulars were refused.

When a big turbo-generator goes out there is a flurry around the station for a few minutes, a new unit is cut in, and two or three months afterward somebody will ask what the accident was down at so-and-so. The engineer under whose administration it happened and the attendants in the plant do all they can to hide it; the management, mindful of its responsibility to the stockholders, jealous of its reputation for uninterrupted service, fearful of the shyster lawyer and damage suits, covers it up; and the builder of the apparatus, apprehensive of the sneering comments of competitors and with the sales department's aversion to admitting that its apparatus is subject to any sort of derangement, does all that he can to fix it up and get it going without the fact of the accident being made public.

Some engine builders used to accuse us of dancing upon their graves when we tried to report their mishaps, but most have welcomed a real investigation and been glad to help us to find the facts.

We should be equally glad to give the truth of turbine accidents, to analyze the causes, show the results and draw such lessons from them as would tend to reduce the probability of their recurrence. But we must first know of the accidents before they become ancient history and then we must have access to the facts and particulars, an analysis of which is apt to be a whole lot more recondite and difficult than was the case with the reciprocating machine. If our friends will be thoughtful and trustful enough to let us know when they learn of such an accident we will do our best to find out about it and to publish a truthful and intelligent account of how it happened.

Yours truly,

F. R. Low,
Editor.

Fred R. Low/HJM.

Correspondence

The Care of Turbine Oil

The article on page 174, Aug. 7, is especially timely at this season, when more "heat troubles" in steam-turbine plants occur than at any other time of year. In nearly every case the first evidence of trouble is high bearing temperatures caused, as stated in the article referred to, by the rapid circulation of the oil in intimate contact with air, water and sediment. This sediment, or muck, usually consists of oxidation products of the turbine metals and the oil, together with the dust and other solid impurities that find their way into the system. It is possible, but not practicable, to make the oil reservoirs of turbines large enough for effective precipitation and cooling. The solution of the problem, therefore, is to treat the oil outside of the turbine system, then to return it, purified and cooled, ready for recirculation.

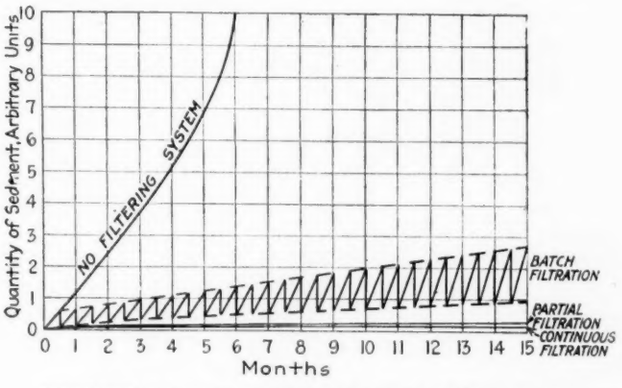
The first step in the treatment of oil is the separation of entrained water, as it is a source of danger, because it accelerates oxidation and tends to form an emulsion with the oil at the high speed and temperature; and the emulsion will, if not discovered in time, get between the journal and bearing, but will not make a satisfactory film. Next, the sediment should be removed and the filtered oil then cooled before being returned to the circulating system. As the oil is purified before passing over the cooling coils, no sediment is deposited on them, and a high rate of heat transfer can be maintained.

There are in general three methods of treating turbine oil—namely, the so-called "batch," "continuous" and "partial filtration" systems. Cooling may or may not be employed in any of these, but ordinarily it is used in the two last named. The operation of the batch system is as follows: When the turbine is shut down, the used oil is run into the upper, or "dirty oil," compartment of a filter, where precipitation of water and heavier impurities takes place. A heating coil in this compartment may be used, should it become necessary to warm the oil. The partially purified oil then flows to the filtering compartment, where final purification takes place, thence to the lower tank or clean-oil compartment, ready for re-use.

The continuous filtration system would, if practicable, be ideal, for, as the name implies, all the oil in the system is continuously passed through the filter at every circuit through the bearings. This system is often used on small turbines, but on the larger-size machines it is not practicable, owing to the great quantities of oil circulated because the filtering equipment to handle this quantity continuously would be about as large as the turbine itself.

For turbines from 1000 kw. upward, the partial filtration system is rapidly gaining in popularity. This is really a bleeder system, in which some of the oil is continuously drained from the lowest, and hence the dirtiest, point in the base of the turbine to the filter, where water and sediment, or muck, are removed and the clean oil cooled and returned to the circulating system. A float-controlled valve keeps the turbine base from being drained and the filter from being flooded and serves to keep the filter working at its maximum capacity. An automatic governor is generally used in connection with the pump, so that the level of clean oil in the filter is kept within predetermined limits. While the processes of purification are the same in the partial as in the batch filtration system, quite a different type filter is employed. The batch being essentially a storage proposition, the rate of filtration may be comparatively slow. The opposite type of filter is called for in the partial system. Here the rate of filtration is rapid, but very little storage space is provided.

The "dirt curves" shown in the illustration give an interesting comparison of the several methods of treating oil. By plotting the quantity of sediment against time, curves about like those shown will be obtained. It is difficult to set a standard of measurement of the quantity of sediment or "degrees of badness" of the oil, because of the wide variation in the grades of oil, the make and type of turbine, the conditions of operation and numerous other factors, and because of the difficulty of securing a representative sample of the oil in the base of the machine. Probably the assumption that oil, if not treated in any way, will be useless for turbine lubrication at the end of six months would hold for the majority of plants. In the curve for the batch system, it is assumed that the oil is filtered every two weeks. The deterioration is gradual, the oil being almost, but not quite, restored to its original lubrication value at each cycle. It is surprising how proper treatment will prolong the life of the oil, as well as insure the machine against bearing troubles. In one plant where a partial filtration system is serving a 3000-kw. turbine, the oil shows no sign of deterioration after more than 18 months of continuous service. There is no deposit in the base of the turbine, because the



CONDITION OF OIL AFTER SEVERAL MONTHS' USE

oxidation products are continuously drained from the lowest part of the base to the filter and removed.

Turbine-oil difficulties are usually expressed in terms of cooling (or rather heating), but purification is really the heart of the problem, because it is the lack of proper purification that allows the formation of sediment and emulsion, these in turn affecting the cooling efficiency. If turbine oil is continuously purified, either as a whole (continuous system) or in part (partial filtration system), most of the cooling difficulties will disappear, and there will be practically no "wear-out" to the oil. It has been found that aside from a slight increase in viscosity, caused by the evaporation of the lighter constituents, there is practically no change in its lubricating value even after years of service. W. J. OETTINGER.

Cleveland, Ohio.

In my opinion, this subject is worthy of a great deal of discussion. In one case on a 300-kw. vertical turbine, the oil circulated at such a high rate that it broke down the filtering cloths, and on account of the improper location of the cooling coils it entered the pumps at a temperature exceeding 200 deg. F. If an observer got the bearing discharge between himself and the sunlight, a blue vapor could be seen rising, having the appearance of smoke; and more than once the operator thought he had a hot bearing. After a few weeks' run, a coke-like deposit could be taken from the bottom of the filter tanks with a shovel, and this with high-grade oil, too. This oil got quite a lot of water in it, from the steam seal above the step-bearing. The wonder is that the oil worked as well as it did, for under these conditions, quantity and quality of the oil are bound to suffer.

On another turbine of the horizontal type, the oil worked at about 175 deg. and would get frothy and yellow in appearance; after running a short time, there would be a thick slimy sediment in the reservoir. This reservoir was open to the same objections as the other; that is, the oil discharged from the bearings into a screen with the pump suction directly below it, when the logical place would seem to be at the other end of the reservoir and a few inches above the bottom, where the oil would be slowed down a little. The reservoir in this case held about three barrels, and perhaps only about half that amount was in active circulation.

In a smaller machine of the same type, the oil ran from October until March, with very little addition. On cleaning, it was a matter of some surprise to find almost no sediment in the reservoir. The length of time between changes was too long, it is admitted, but it certainly speaks well for the quality of the oil. This oil works at a high speed and high temperature; but there are no figures available, as no thermometers are used.

I believe the proper system to use is what is called the "batch system," where the oil is taken out of service, thoroughly filtered and put back again, a close watch being kept all the time to keep the oil up to grade. A check should be kept on the viscosity and specific gravity, and new oil added from time to time as necessary. A continuous system does not give the best results, as there is hardly time for the water and other foreign particles to settle out. There are several filters and coolers on the market, and in these days of high prices it behooves the engineer to keep down costs by conserving the lubricating oil, as well as other supplies. J. A. WATKINS.

Jefferson City, Mo.

Engineer (?) Wanted

I am inclosing a clipping from the "help wanted" column of the Kansas City *Times* of a recent date, that is self-explanatory. What type of "engineer" will $50 per month and a 12-hour shift attract? I would like to know what real engineers think of such a condition of affairs.

ENGINEER, steam, experienced, wanted at once for ice and electric plant; permanent position; $50 month; 12-hour shift. Eureka, Kan.

Mexican track laborers receive more pay for work on the railroad track running through that town.

Emporia, Kan. H. I. REEDER.

Fittings for Alternating Current Conductors

In the issue of July 10, W. F. Shedinger's article, "Iron Fittings Caused Voltage Drop," commenting on the methods of running alternating-current conductors through holes in a wall bushed with iron pipe and on supporting these conductors on clamps, is quite correct. Any form of clamp or bushing composed of all iron or steel will have eddy currents induced in it. We are using a clamp such as described in the article in question for 2300-volt alternating-power conductors, but the metal is of two kinds. The base, or bottom half, is of cast iron and the top half cast brass or some similar metal. The same principle could be used with good results in wall bushings. Although we have a large number of these clamps in use, no trouble has been experienced. H. KLEIN, JR.

Monroe, N. Y.

The trouble referred to in Mr. Shedinger's communication entitled "Iron Fittings Cause Voltage Drop," on page 59 of the July 10 issue, was due to the use of split porcelain bushings with the bottom part of the metal base and also the encircling strap made of malleable or cast iron. These are suitable for direct-current work only. It is well recognized that in alternating-current work either the metal base or the metal inclosing strap should be made of some nonmagnetic metal. This feature is recognized and provided for by practically all concerns that manufacture this type of cable clamp. They furnish them for alternating-current work usually, with the base made of malleable iron and the encircling strap of hard brass or composition metal, either of which is nonmagnetic. They also take particular pains in their bulletins and catalogs to point out these differences in the construction of the two kinds of cable clamps, for direct-current and alternating-current work respectively. Therefore, if proper consideration is given to the selection of cable clamps for alternating-current conductors, no trouble should be experienced.

This arrangement in the cable clamps for alternating-current work prevents the formation of a complete magnetic circuit, consequently the circulation of any current and the heat which would be produced thereby.

Fairmont, W. Va. R. P. HINES.

Co-ordinating Power with Heating

The heat that is thrown away by steam-power plants would be sufficient to heat all or most of our homes and other buildings, and for a large part of the year buildings could be heated with water at the temperature at which circulating water from many condensing plants goes to the sewer. It is to be hoped, therefore, that full

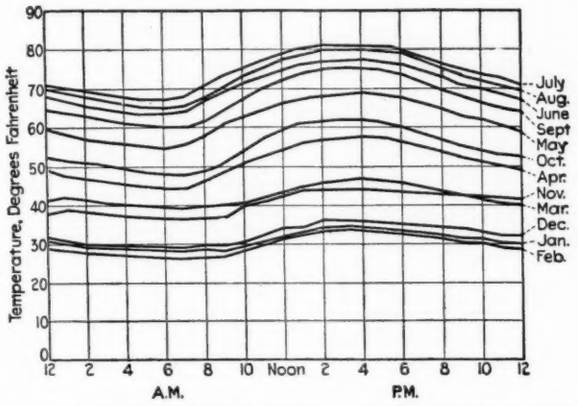


FIG. 1. HOURLY TEMPERATURES AT PITTSBURGH, PENN.
Monthly averages for 20 years (1891-1910) U. S. Weather Bureau observations

consideration will be given to the excellent articles by Ira N. Evans in two recent issues of *Power* (page 684, May 22, and page 732, May 29, 1917), on the economical utilization of this byproduct heat; or, putting it the other way around, the production of power as a by-product of the heating system.

The accompanying charts will help in visualizing the situation as it exists. Fig. 1 shows the hourly atmos-

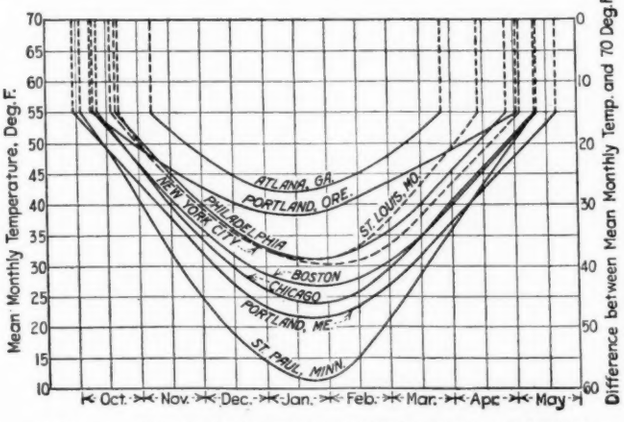
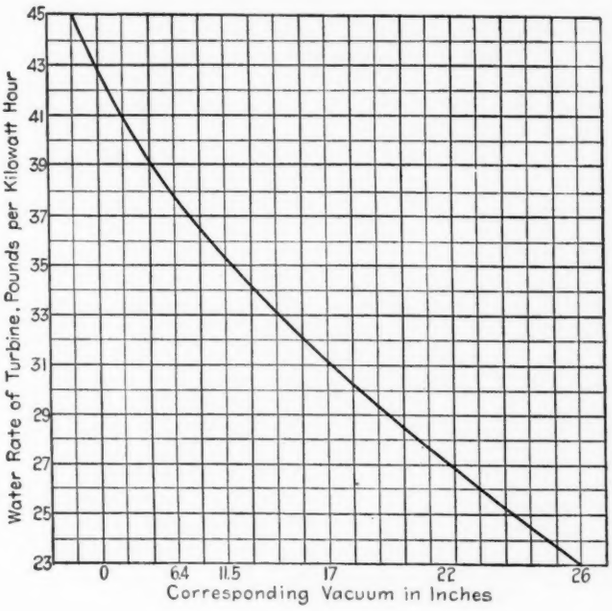


FIG. 2. MEAN MONTHLY TEMPERATURES DURING HEATING SEASON IN NINE CITIES

pheric temperatures at Pittsburgh, based on monthly averages for 20 years of observations by the United States Weather Bureau. Fig. 2, by E. F. Tweedy, shows the mean monthly temperature during the heating season in nine of our leading cities. It is based on the assumption that artificial heating is required when the mean outside temperature is below 55 deg. F. and that the amount so required is proportional to the difference betwen 70 deg. F., the assumed inside, and the mean outside temperature. Fig. 3 shows the temperature of circulating water likely to be required for different outside temperatures. It is evident from these charts that a heating plant can carry a vacuum for most of the year. A close approach between the temperature of the circulating water and the temperature corresponding to a given vacuum is difficult of attainment in



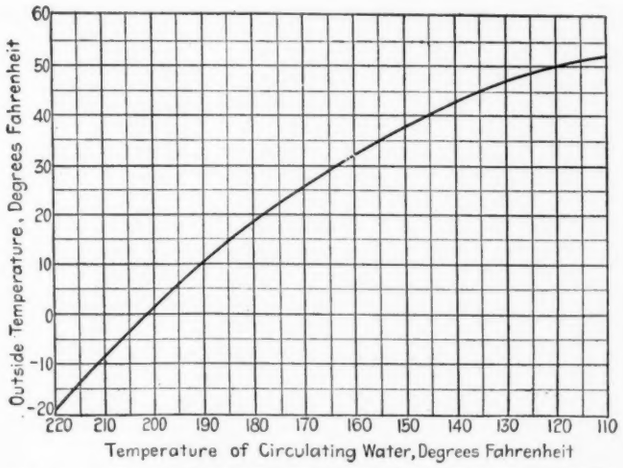


FIG. 3. 500-KW. TURBINE COMBINED WITH CONDENSER HOT-WATER HEATING SYSTEM.
Circulating water assumed 2 deg. less than steam temperature at atmosphere to 10 deg. less at 26 in. vacuum

a closed heater, which is in reality a surface condenser, without the use of a large amount of tube surface, but it is easily obtainable in a properly designed jet condenser, or open heater. Some of the advantages of the jet condenser or open-type heater are:

1. The smaller temperature difference between the steam and the water just referred to, resulting in a higher temperature of the water for a given back pressure on the engine, or conversely, a better vacuum for a given water temperature, securing in either case a lower steam and fuel consumption by the engine.

2. It maintains its efficiency indefinitely, as it does not accumulate grease or scale on the heating surface, to its detriment, neither is it subject to leakage or bursting because of high water pressure.

3. With the open feed heater the piping of the heating system is protected against oxidization, as the air is driven out of the water by spraying through the steam bath. Where raw water contains considerable air and carbon dioxide or scale-forming matter, open heaters can have a two-compartment tank, so arranged that the water passing through the heating system will only be the distilled and deaërated water. This circulating water is constantly augmented by the steam condensed in heating it, and the excess overflows into the other compartment of the heater, into which the raw water is received.

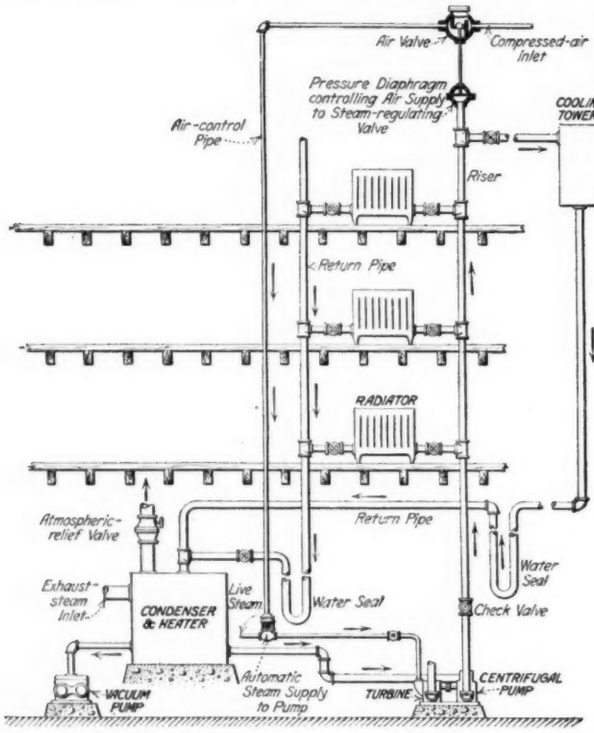


FIG. 4. WATER-HEATING SYSTEM CARRYING A VACUUM CORRESPONDING TO THE DESIRED WATER TEMPERATURE

4. The open heater costs less than the closed heater.

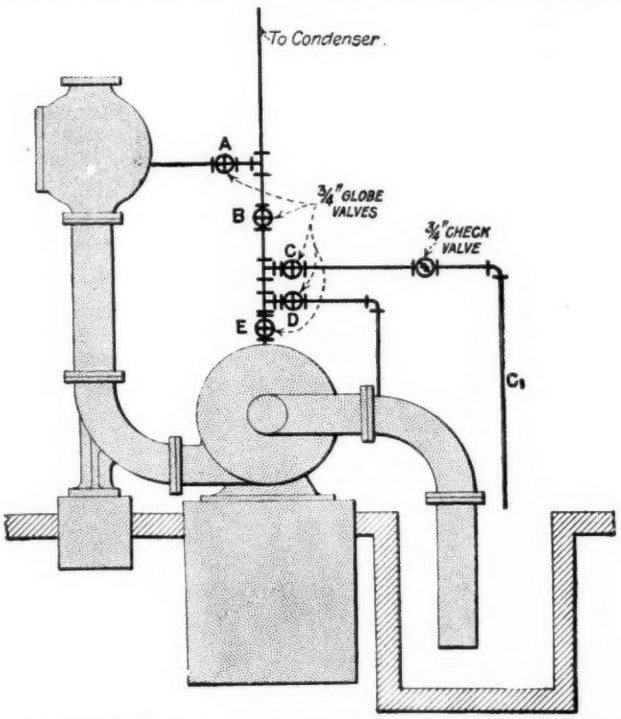
The open heater must, of course, be installed at the top of the circulating system, or some other means must be devised for allowing the water to flow back to it without pressure. In many mill plants the resistance of the radiators and piping is such that if the water is pumped to the highest point of the system and allowed to flow back to the heater, very little pressure will result. It is then only necessary to automatically regulate the pump to discharge to the highest point of the system, as suggested in Fig. 4. The heating system as a heat dissipator is most effective in cold weather, when the hottest water is desired, and least effective in mild weather, when very little heat is wanted in the radiators. An auxiliary cooling tower can be so regulated that the back pressure or vacuum in the condenser is controlled to suit weather conditions.

Unfortunately, the maximum heating load usually does not come at the same time of day as the maximum power load. For example, in a hotel the maximum heating load occurs in the morning, when the building has been cooled off by bedroom windows having been left open overnight and there is the maximum demand for hot water, while the maximum power load occurs in the evening, when all elevators are running and lights on. It will be found, however, that enough heat can be stored in a moderate amount of water at 210 deg. F., during the heavy power-load period, to supply all or nearly all the heat required during the heavy heating-load period. The amount of storage required for equalizing depends on the condtions in each case. In mild weather all the heat required in the morning can be stored in reservoirs of not excessive capacity, while during the short period of extreme cold, live steam can be drawn on to heat the water during the daily period of heaviest heating load.

New York, N. Y. GEORGE H. GIBSON.

Priming a Centrifugal Pump

We had a 13,500 gal. per min. centrifugal pump that was difficult to prime and it would lose its suction frequently. It was used to lift water to a tank for supplying the jet condensers, and it was essential that the supply be constant. The difficulties were overcome by the system of piping shown in the illustration. The pipe



VACUUM FOR PRIMING DERIVED FROM LIVE CONDENSER

so marked was connected to the condenser, which was always working before this pump was required. Before starting, all the valves were opened for a short time to exhaust the air, but when the pump was working up to speed valves *A* and *D* were closed and *B* left about one-quarter turn open and *C* and *E* left wide open. With the pump working properly, water discharged from pipe C_1, but if it failed no water discharged from this pipe, so it acted as a telltale. The check valve prevented any back flow of air into the pump or piping.

E. S. RAY.

Arthur, Ill.

Turbines Failed To Carry Load

Regarding F. R. Arnold's question in the issue of Sept. 4, page 332, he does not give enough information as to the type or make of turbine to make possible a very detailed reply. The fact that the machines carried a full load without trouble when they were first put in convinces me that the trouble may be in the strainers in the steam line. The steam main may have had considerable dirt or scale in it, and this may have become packed in the strainer so that the full volume of steam could not get through. The fact that 175 lb. is carried on the main does not prove that it is up to that at the nozzles of the turbine. If the strainers are clean, then he should look to the nozzles, as it is possible that some of them are plugged with scale or other foreign matter.

I do not think that any motor-controlled synchronizing spring can reduce the speed of a machine enough to cause trouble, as full load can be carried with all the tension on the spring, and only a slight decrease in frequency will result when everything else is all right.

It may be possible that the admission valves are sticking and do not give full opening, but this trouble would be too noticeable to be overlooked. With holes tapped in the casing at points opposite each stage of the turbines, it is possible to determine what the different stage pressures are and the drop in or between stages. I should judge that the blading was all right, as the chances of stripping blades or of their straightening out or plugging up with scale in both turbines at the same time seems rather remote. A great number of suggestions might be made, but my first would have been to send for one of the engineers from the builders' shop. As they are "up against" all kinds of trouble, this is generally the best, quickest and the cheapest way out of a difficulty of this kind in the long run.

Haverhill, Mass. WILLIAM F. O'REGAN.

As a possible remedy to F. R. Arnold's turbine trouble, I would cite an incident in my own experience that was very similar to his. In my case a 350-kw. turbine had, on its trial run, carried a 10 per cent. overload with ease, but shortly afterward a reduction in capacity was noted and the trouble increased until the machine would "lay down" on half-load. The trouble seemed to be that the machine would not keep up to speed as the load increased, indicating a possible governor trouble. After spending considerable time on the governor, etc., I had the piping disconnected and found a large nut in the first-stage nozzle that reduced the nozzle opening more than one-half. No trouble was experienced in carrying the rated load after that.

Not long ago I was asked to inspect some new turbine-driven blowers, one of which lagged badly. I learned that the piping had not been blown out before the machines were connected. The removal of an accumulation of iron rust, etc., cured the trouble in this case. It would have been helpful if Mr. Arnold had mentioned the type or make of turbine he is running.

South Quincy, Mass. A. D. PALMER.

There are many things that may cause the trouble. As to the auxiliary synchronizing spring, I have run turbines at different times a full watch with the spring to the limit, both high and low, and the turbine worked fairly well and took its load at either high or low frequency, whichever it happened to be. Following are some troubles I have had or known of: In a hydraulic gear a slipped crosshead on the pilot-valve stem, camshaft not in proper setting, and broken or missing lifting pins; with a mechanical gear, broken or missing latches or latch blocks, bell crank loose on stem on the top of the governor and valve stem misadjusted or sticking badly. The foregoing faults are indicated on Curtis turbines by the valve not opening. In the Westinghouse small units, I have had a stuck governor spindle, bent lever, also causing binding, bent and broken governor-valve stems, and have had a two-piece governor valve warp and stick, refusing to open. Also the emergency stop came out part way and kept the turbine from carrying the full load, and a bent stem kept it from shutting the steam off. The following ailments are on the steam side from the header throughout the turbine: Partly closed line valve, clogged strainer, throttle valve not fully open or clear, broken or loose admission valves or stems, clogged valves or nozzles, blading missing, clogged or coated with scale and a choked exhaust. A steam gage connected directly to the steam chest will show the drop and also the pressure at the admission valves. It is good for keeping a lookout for a clogged strainer. W. F. CLANCEY.

Erie, Penn.

In answer to F. R. Arnold's request in *Power* of Sept. 4 for a solution of why the turbines fail to carry their rated load, I would suggest that the trouble be looked for in the steam-line strainer. The strainer furnished with some turbines is a good baffle, especially if the boilers have primed and the water carries scale over to lodge in it.

In one plant where I worked, it was a regular occurrence to remove these strainers for cleaning, and I would suggest to anyone having this to do that he first secure the right number of proper-sized nuts and split the ones on the strainer cap with a chisel. In trying to turn them off, there is danger of wrenching the studs in two. R. B. GOOLD.

Leadville, Colo.

Bonus Plan for Power Plant

In conversation with the superintendent of a power plant, the writer was told of a bonus plan that was under consideration. This plant has a detailed log of the operating costs. The boiler room is well equipped with recording instruments and the engine room has two steam meters—one connected to the main units and the other to the auxiliaries. The bonus plan contemplates making a graphic chart showing the pounds of fuel used each half-hour at all the various rates of evaporation deduced from the past yearly record; and for the engine room, a chart will be made of the steam used per kilowatt output at the various load factors. These values will include all the steam except that used by the boiler feed pumps. This item is charged against the boiler room. In operation, a daily log will be made of the boiler- and engine-room operations and checked against the charts and the saving or loss in the operation during the shift determined.

The bonus accruing to the operators will be 60 per cent. of these savings. By separating the engine and boiler rooms, it is comparatively easy to determine where the saving is being made and divide the reward accordingly. It is evident the boiler-room force will gain a better bonus than that of the engine room, for the reason that the boiler room offers greater opportunities for improvements in operation, and the human element enters to a larger extent. Nevertheless, the engin-room force can gain a bonus by close attention to the condition of the auxiliaries and by having the main units carry a fair load at all times. It is surprising that so few of the large power plants have adopted the bonus plan. In a plant having a fuel expense of $25,000 to $50,000 per year the saving may be great, for it is not difficult to effect a saving of 5 per cent. in the fuel charges; and even in plants where the fuel cost is as low as $20 per day the saving may be considerable, but the better feeling and teamwork in the operating force are worth even more.

The saving in fuel is not the only way employees may gain a bonus. The incidentals, such as waste, oil and packing, in large plants amount to a big sum. Furthermore, there are frequently repair jobs sent to an outside shop, which could be handled by the operating force if there was an incentive to do such work.

Dallas, Tex. E. S. MORRISON.

A Preventable Accident

About ten minutes before shutting-down time, Saturday, Sept. 15, a young machinist who had charge of the 8-hp. steam engine that ran a New York machine shop was seriously if not fatally injured when his jumper caught on the key protruding from the hub of the engine flywheel. His skull was fractured, and both arms and one leg were broken.

The cause of the accident is easily explained. The engine flywheel was on one end of the crankshaft, from which the key protruded and to which no safeguard had been applied either in the shape of a cap or a rail around the flywheel. Consequently, when the engine runner passed the flywheel on his way to shut down he stopped by the flywheel to speak to a workman and the suction drew the loose end of his jumper in far enough for it to catch on the key, Fig. 1. The jumper was instantaneously wound up in a ball at the man's back, Fig. 2, and as it did not give, the man was whirled about, resulting in the injuries as stated, although a fellow workman quickly stopped the engine.

FIG. 1. JUMPER JUST ABOUT TO CATCH ON KEY

FIG. 2. A SECOND OR TWO LATER

Immediately following the accident steps were taken to prevent a repetition. A ring of $\frac{1}{16}$-in. sheet metal was formed into a band to fit snugly over the hub of the flywheel. To this a cup-shaped cap, which was found about the plant, was brazed to the ring, as the cup was not deep enough to fit on over the hub.

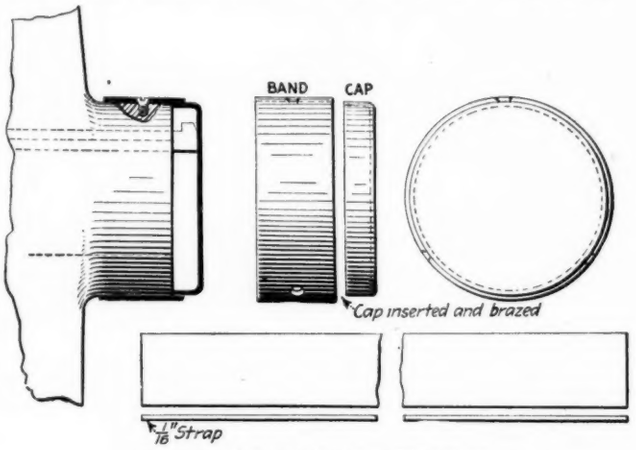


FIG. 3. CAP TO COVER THE KEY

New York City. J. A. LUCAS.

Using Gaskets Over Again

Regarding the re-use of boiler manhole and handhole gaskets, we are using Stirling boilers at 150 lb. pressure, letting them down every two weeks for cleaning. Formerly, we used gaskets two or three times and then replaced them with new ones, but now we have used the same gaskets for a year and they are still in good condition. To make sure that the plates were put in the same position each time, I took a scriber and marked the bottom of the plate even with the flange on the boiler head in two places about 10 in. apart, also marking the flange opposite the marks on the plate. I then took the plate out and drilled and tapped holes $\frac{5}{16}$ in. below the marks for $\frac{3}{8}$-in. dowel pins, then with a small round file made $\frac{5}{16}$-in. notches in the flange on the head, forming a resting place for the dowels. This insures that the manhole plate will always be replaced in the same position. And it can be easily placed there by anyone, whether especially skilled in such work or not. We never disturb the surface of a gasket, simply wiping it off with a piece of waste and applying a coat of graphite, and are never troubled with leaks.

Las Vegas, Nev. J. S. FLEMMING.

Inquiries of General Interest

Running Motor in Vacuum—What would be the effects of operating a motor in a vacuum? J. C. S.

An electric motor operated in a vacuous space would run just as when surrounded by air, but rather less current would be required to deliver a given power because there would be no windage or air resistance to be overcome. This saving would amount to less than ½ of 1 per cent. On the other hand it would be impractical, because without air to conduct away the heat generated in the various parts, the machine would soon become very much overheated.

Diameter of Boiler Tubes—What diameter should be allowed for tubes of a horizontal return-tubular boiler 16 ft. long? T. G.

For boilers operated under natural draft, a common rule is to allow one inch of nominal tube diameter for each 4 ft. of length when bituminous coal is used and for each 5 ft. of length when the fuel is anthracite. To conform to this rule, tubes 16 ft. long should be 4 in. outside diameter for use with bituminous coal and about 3¼ in. outside diameter for use with anthracite. With artificial draft smaller tubes can be used, according to the force of draft employed.

Use of Mixed Sizes of Coal—What effect has the use of mixed sizes of coal on the economy of boiler furnaces? J. C. M.

When mixed sizes are fired, the smallest pieces of fuel are soonest reduced to ash, which obstructs the draft and blankets larger lumps of the coal that are only partly burned. This results in a dirty fire, which cannot be cleaned without loss of unburned fuel dropping through the grates, and impairs further combustion of the incompletely burned coal that remains on the grates. The more nearly uniform the size of coal used the better the furnace control and higher the economy obtainable.

Use of Coil in Back Connection of H. R.-T. Boiler—What would be the effect of placing a coil of 2-in. pipe in the back connection of an 18 ft. x 72 in. return-tubular boiler and pumping the feed water through the coil? The present temperature of the feed water is about 200 deg. F. E. T.

The proposed coil would be equivalent only to adding about 65 sq.ft. to the present heating surface of the boiler, and if kept clean of soot, it might be considered as increasing the size and capacity of the boiler about 5 per cent. But the employment of such additional heating surface cannot result in appreciable improvement of economy unless the temperature of the uptake gases is excessive, thereby indicating that additional heating surface would be beneficial.

Gaging Length of Valve Rods—How could an order be given for the length of radius rods for operating the valves of a Corliss engine without introducing errors of rule or scale measurements of the lengths? H. F. L.

The lengths of such connecting-rods are always to be understood as the distance from center to center of the pins. Remove the rod whose length is to be obtained, place the wristplate in its central position and place the valve so its opening edge will be over the edge of the port and clamp the valve in that position by setting the spindle stuffing-box gland down hard. Then cut a pine rod so its length, end to end, will be a gage for the machinist to follow for the distance from face to face of the wristplate- and valve-arm pins. This length, plus half the diameter of each pin, will be the center-to-center length for the rod when made up without spare adjustment of its length for valve setting, which for average-sized engines should permit of lengthening or shortening of the rod about 1¼ inches.

Power Required for Compressing Air—Neglecting the efficiency of the compressor, what number of horsepower would be required to compress air from atmospheric pressure and deliver 100 cu.ft. of air per minute at a pressure of 26 lb. gage? L. G. L.

The free air, or air required to be handled at atmospheric pressure, to make 100 cu.ft. at 26 lb. gage would be

$$100 \times \frac{26 + 14.7}{14.7} = 276.8 \; cu.ft.$$

The theoretical number of horsepower required to compress and deliver one cubic foot of free air per minute is given by the formula,

$$\frac{1.511}{100} P (R^{0.29} - 1)$$

in which P is the initial pressure and R equals the number of compressions. With compression from atmospheric pressure, or 14.7 lb. per sq.in. absolute, to 26 lb. gage, or 26 + 14.7 = 40.7 lb. absolute, the number of compressions would be 40.7 ÷ 14.7 = 2.76. By substituting in the formula, the number of horsepower required would be

$$276.8 \times \frac{1.511}{100} \times 14.7 \; (2.76^{0.29} - 1)$$

Log $2.76^{0.29}$ = log 2.76 × 0.29 = 0.440909 × 0.29 = 0.1278636 = log 1.342, hence the power becomes

$$276.8 \times \frac{1.511}{100} \times 14.7 \; (1.342 - 1) = 210.3 \; horsepower$$

Chloride-Accumulator Type of Storage Battery—Why is the term "Chloride Accumulator" applied to a type of lead storage battery and how are the plates of this battery constructed? A. A. F.

The term "Chloride Accumulator" is the trade name given to a storage battery that was introduced in the United States in 1887. The name is descriptive of the material, "chloride of lead," from which the active material of the positive and negative plates in this battery was derived, the material being changed in the process of manufacture to "lead peroxide" in the positive plate and a finely divided form of pure lead called "sponge lead" in the negative plate. In the manufacture of both positive and negative plates the lead chloride was used in the form of pastils or buttons and incorporated in the grid of the plate. For the last 12 or 15 years, chloride of lead has not been used in the manufacture of either the positive or the negative plates, but the trade name "Chloride Accumulator" is still in use.

In this type of storage-battery cell as now constructed the active material of the positive plate is made from pure lead buttons incorporated in a lead-alloy grid and partially formed into lead peroxide. This positive is known as the Manchester positive.

The active material in the negative plate known as the Box negative is made from lead oxide and in its active form becomes finely divided pure lead called "sponge lead." This active material is contained in the compartments of an alloy grid. Each face of the plate is covered with a perforated lead sheet that serves to hold the active material in the compartments.

[Correspondents sending us inquiries should sign their communications with full names and post office addresses. This is necessary to guarantee the good faith of the communications and for the inquiries to receive attention.—Editor.]

Alternating-Current Motors Used To Operate Grab-Bucket Coal Hoists*

By James Farrington and R. H. McLain

In order to show the status of alternating-current motors for coal-hoisting work, a brief comparison will be made between a polyphase alternating-current and a direct-current installation. With regard to transmission systems, alternating current is easier to transmit at high voltages than direct current, but when alternating current has to be transmitted at low voltages and long collector rails have to be installed, it is at a disadvantage because three wires are necessary, whereas with direct current only two wires are required, and in some cases one of these may be omitted and a ground used. Frequently the local conditions are such that the difficulty of using a proper transmission system with alternating currents really decides the case in favor of direct current.

The next point of comparison is in regard to hoisting the load. For this purpose alternating-current and direct-current motors are practically on a par. Suitable speeds for gearing or direct connecting can be obtained with either motor; and power economies, maximum torques and other features are practically the same. However, it is necessary, where an alternating-current motor is used, to go to greater trouble and expense to maintain a uniform voltage than it is where a series-wound direct-current motor is employed, because a widely fluctuating voltage might result in a good alternating-current motor failing to exert proper starting torque; whereas with direct-current series motors, line voltage has practically nothing to do with the starting torque of the machine.

Motors for Accelerating Heavy Loads

The direct-current motor has by far the advantage over the alternating-current motor for accelerating heavy loads to high speeds. For instance, on a man trolley or other propelling motions, where the maximum speed to be obtained on a horizontal track is something like 1000 ft. per min., the alternating-current motor has to weigh approximately twice as much as the direct-current machine and be twice as large in every respect in order to accomplish the same amount of work. This advantage of the direct-current over the alternating-current motor does not amount to much at slow speed, like 300 or 400 ft. per min., for trolleying purposes, and hardly amounts to anything for any of the particular hoisting speeds and hoisting conditions that are used in this class of work.

The big problem so far on most coal towers has been the lowering of the bucket. The problem has been solved and practically standardized where direct current is used, by making use of dynamic braking. Direct-current motors and controllers lend themselves admirably to dynamic braking, and this kind of braking can be used to the fullest extent without adding very much to the size of the motor or to the complexity and cost of the control. Up to the present time this problem has not been so thoroughly solved with alternating-current motors as to result in any settled practice.

In order to lower a bucket properly into a boat without damage to itself or the boat, it is necessary to maintain a uniform speed of some certain amount just as the bucket is about to strike the coal. The exact value of this speed will depend on the size of the bucket, the amount of coal in the boat and the kind of boat used. For large buckets like the 5- and 10-ton buckets used on the Great Lakes in connection with large steel boats, it is desirable to have a bucket speed of something like 40 to 60 ft. per min. Two- or three-ton buckets used on the same boats might very well be lowered at a speed of from 150 to 200 ft. per min. Two- and three-ton buckets when used on wooden barges should be lowered at a speed of about 125 ft. per min. When digging in the coal where there is no danger of striking the boat, it is desirable for the bucket to enter the coal at something like 500 to 600 ft. per min., so that the bucket can penetrate well into the coal and thereby increase its digging capacity.

In order that an alternating-current motor may be used successfully with this kind of work, it is necessary to obtain some method of controlling its speed when lowering the bucket so as to accomplish the results described in the preceding paragraph. If, for example, the motor is geared for a hoisting speed of 125 ft. per min. and a 3-ton bucket is used, all that is necessary to do is to put on plain reversible control with no provisions whatsoever for reducing the speed of the motor as the bucket strikes the coal. It is necessary, however, to provide some kind of a brake for stopping the motor and also for holding the bucket suspended after the motor is stopped. For these purposes the ordinary commercial solenoid brake is well adapted. This is called regenerative control and makes a very simple outfit indeed.

Brake Must Be Used with Controller

When the motor is geared for higher hoisting speed than 125 ft. per min., the same method of control can be used as outlined in the foregoing, but it is necessary to design the solenoid brake carefully so that it will meet the heating requirements of the duty cycle, and it will be necessary to provide it with easy means of adjustment so that it does not stop the load too quickly or too slowly. This method of control is not very satisfactory if there is much variation in the load; that is, if at some time a loaded bucket has to be lowered and stopped and at other times an empty bucket. However, such method of control is practical up to hoisting speeds of around 300 ft. per min. if two solenoid brakes are used with controller points for each brake. Hoisting machines having speeds as high as 1200 ft. per min. have been operated by lowering the bucket at full-speed regenerative control and then stopping it by means of one solenoid brake in combination with one foot-operated brake, used for assisting the solenoid brake. Hoisting machines have been worked out where the bucket was lowered by means of regenerating braking at speeds around 700 or 800 ft. per min. and stopped by shutting off power and applying air brakes. Air brakes give the necessary flexibility of speed control because graduated braking can be obtained.

All the schemes outlined in the foregoing are thoroughly all right and practical so fas as getting control of the bucket speed is concerned. But when buckets greater than two-ton capacity are used at rope speed about 500 or 600 ft. per min., making more than two trips per minute, it becomes very hard to design and build proper friction brakes which can withstand the wear and tear and get rid of the heat generated in a rapid-duty cycle. It is for conditions beyond the limits mentioned that dynamic braking can be used to solve the problem. Dynamic braking can be used in combination with regenerative braking. That is, the buckets can be lowered practically the whole distance by regenerative braking, and then stopped from full synchronous speed of the motor down to something like 120 ft. per min. on the bucket by means of dynamic braking. Some kind of a friction brake is required to hold the load and stop it from 120 ft. per min. But this friction brake is relieved of all wear and heating which would be encountered in dynamic braking when it is used. It is also feasible to use dynamic braking, not only for stopping the load, but for lowering it as well.

Dynamic and Regenerative Braking

The choice between the use of dynamic braking in combination with regenerative braking, or dynamic braking alone, should be based on various considerations such as the cost of power, the ability of the particular motor sizes to dynamic braking and the complication. If a large amount of power can be saved by using regenerative braking and if regenerative braking can be left on for a long period of time in lowering, the choice should generally be made in favor of a combination of regenerative and dynamic braking; but if power is not very expensive and if regenerative braking could not be left on for more than two or three seconds while in the act of lowering, there is hardly any use of complicating the situation by the use of regenerative braking.

*Abstract from a paper, "Grab-Bucket Coal Hoists Operated by Alternating-Current Motors," presented at the Eleventh Annual Convention of the Association of Iron and Steel Electrical Engineers, held in Philadelphia, Penn., Sept. 10-14, 1917.

Commands Producing Injuries

By Chesla C. Sherlock

In the absence of express statutes on the subject, what is the effect at law of a master's direct command to a workman to act which results in the workman's injury?

One authority has said that although the direct command of the master may modify to some degree the rule of law otherwise applicable, the servant generally does not gain anything by the fact that he is acting in obedience to the master's commands. However, there are some situations where the master's command does change the rule, but even then it is difficult to determine just how much of the result is due to the command itself. Indeed, it has been said that the master's command is but one more circumstance in the case, and that as the circumstances of each case are different, each will have to stand on its own merits.

Where there are no statutes expressly abrogating the doctrine of assumption of risk and contributory negligence, we find that the courts have adopted two views of cases where the workman is injured while obeying the master's direct command. On the one hand, the courts say that the doctrine of assumption of risk and contributory negligence are not affected in the least because of the fact that the servant was injured while carrying out a direct command of the master. On the other hand, many courts say that the direct command negatives the doctrine of assumption of risk and that the question of contributory negligence is one for the jury to determine.

Before carrying this discussion further, it should be kept in mind that the mere fact that the master has issued a command does not cause liability to attach to him. No liability attaches to the master because of his command unless he is in some way negligent, either in connection with the order or in connection with the conditions under which the order must be executed.

No Liability Without Negligence

An Illinois case specifically decided that the master's order would not create any liability on his part if he was not negligent in respect thereto. In a California case it was said that negligence would not be inferred from the mere fact that the servant was ordered to do a dangerous piece of work, but that some act of positive negligence must be shown. A long line of cases have said that a direct command to do a thing does not affect his liability, where the risks incurred are only the ordinary risks of the employment.

Some courts maintain that the doctrine of assumption of risk is not modified by a direct command or order from the master. They state that where the workman is experienced, where the task is obviously dangerous or apparent, the command does not change the rules of law applicable. The courts of the following states have adopted this rule: Washington, Delaware, Pennsylvania, New Jersey, Arkansas, Texas, Connecticut, Alabama, Georgia, Iowa, Kentucky, Massachusetts, Michigan, New York, Ohio, Rhode Island and Wisconsin.

Specific cases will serve to illustrate this proposition. For instance, a servant assumes the risk of slipping of an ordinary ladder, although directed to use the same by the superintendent. The mere fact that a section man walks along a track in pursuance of an order does not relieve him of assuming the risk from passing trains.

Many courts hold that the doctrine of contributory negligence is not affected by a direct command. "The test of contributory negligence in such cases," says the Nebraska court, "as in others, is whether the servant, in obeying, conducts himself as a man of ordinary prudence would conduct himself under the circumstances."

Where a servant knows and appreciates the danger of the act which he undertakes to perform, he does not any the less become chargeable with contributory negligence because he undertakes it under the direction of his superior. In Georgia it was held that an order from a conductor to a flagman to catch a train will not justify the latter in attempting to do so at a time when the train is moving at an obviously dangerous rate of speed.

Another Georgia case held that an employee could not recover damages from a railroad company for an injury caused by his violation of a penal statute or municipal ordinance, notwithstanding the fact that the employer may have ordered him to violate the law.

There are other courts which maintain that a direct command makes assumption of risk and contributory negligence questions of fact for the jury to determine. It will be seen that where this doctrine is recognized, the direct command of the master modifies the rules of law otherwise applicable.

In many of the cases the master's liability is fixed regardless of the command, either by the circumstances of the case or express legislation on the subject. It is unquestionably the rule of law in these jurisdictions that a servant has a right to assume, in the absence of warning or notice to the contrary, that in conforming to the order he will not be subjected to injury.

Where the master adds an assurance of safety to his command, it has been held that the doctrines of assumption of risk and contributory negligence do not apply.

We have found, then, some difference of opinion among the courts on the subject of direct commands. Of course, the states have in many instances hastened to the relief of the workman with legislation on the subject, but there is still room for substantial progress in this field. The workmen's compensation acts have in a measure remedied conditions, but in the main they are still uncertain and an unknown quantity so far as they affect some of the finer points of law of relations existing between master and servant.

Business Men Seek Closer Co-operation With Government

The War Convention of the United States Chamber of Commerce, held at Atlantic City, Sept. 17 to 21, for the purpose of arriving at a more effective understanding between the representatives of the Government and of industry in the conduct of the war, went on record as favoring the following resolutions:

1. A declaration of unanimous support of the Government in every step necessary to the advancement of the cause of liberty and democracy.
2. A recommendation that all war buying be assembled under the control of one board, this board being given full powers as to priority and the fixing of prices, not only with respect to Government purchases, but to the public, when necessary.
3. The extension of sympathy and support to the new Russian republic.
4. A recommendation to all business to coöperate in the forthcoming Liberty Loan.
5. A recommendation that steps be taken by the Government to maintain the parity of the American dollar in all countries.
6. A reiteration of the principles enunciated by the Council of National Defense that neither employers nor employees should endeavor to change at this time the pre-war standards then established.
7. That the Calder Daylight Saving bill, which has already passed the House, receive the favorable attention of the Senate before adjournment.
8. That there be no profiteering by producers, manufacturers, distributors or labor.
9. That American roads and highways be improved as a military necessity for efficient transportation.
10. That war-service committees should be speedily appointed by all industries, the committees consisting of representative men from the industries; that those industries not already nationally organized should take steps to become so at once; that these committees should be truly representative, not only of members of the organizations, but also of those not in these organizations; that these committees be appointed by each industry independent of Government appointment, and given full power to deal with the representatives of the Government in all matters pertaining to the undertaking of Government orders by each industry.
11. That an arbitration board be established consisting of representatives of the Government, of employers and employees, to pass upon all disputes relating to employment and labor matters, and that the decisions of this board be binding, making it illegal to interrupt production either by lockouts or strikes.

12. That universal military training be adopted at once.
13. That the Webb bill permitting coöperation in export trade be favorably considered by the Senate before adjournment.
14. That resident aliens be encouraged to secure naturalization.
15. That an international congress of chambers of commerce be convened at the earliest practical moment.
16. That retail merchants be urged to coöperate with the Commercial Economy Board to reduce waste in distribution.
17. That the United States employment service maintained by the Department of Labor be given further powers for effective work.
18. That a foreign commission be speedily appointed to proceed abroad to study present and after-the-war problems.
19. That in connection with price fixing by the Government, the various industries be permitted from time to time to submit evidence of changing costs of manufacture so that the prices may be changed in accordance where necessary.
20. That it be urged as a recommendation to Congress that war taxes exceeding a certain amount be payable quarterly instead of annually.
21. That the president of the Shipping Board be empowered to employ foreign-built vessels in coastwise shipping, where necessary, as a war measure.
22. That land and water transportation be strengthened as a measure of defense.

Views of Cabinet Officers

The Government was represented directly by three cabinet officers: Secretaries Baker, Lane and Wilson.

Mr. Baker spoke of the wonderful coöperation of business in the building of the cantonments in which the various army and navy forces are to be trained, the supplying of raw material for building as well as for transportation, and mentioned the expansion of the manufacturing facilities of the country in supplying food and clothing.

"There were some anxious moments in Washington," he said, "as to the attitude of business toward the Government," as he spoke of the difficulties of price fixing, "but," he continued, "American business men came to the conclusion that it isn't going to be popular in this country to make money while other men lay down their lives."

"It was the leadership of American business," the secretary declared, "which smoothed away these difficulties."

Secretary Baker warned his hearers against certain forms of overproduction, and spoke of the desirability for proper wages and hours of labor.

Secretary Lane, referring to what has thus far been accomplished, said in part:

"We have supplied money for our friends, raised an army of a million and a quarter, inaugurated a new industry—that of making aëroplanes—revived a dead industry—that of building ships—placed in the hands of the President powers over exports and prices, over industries and resources, made laws to punish domestic enemies, and courageously placed the burden of taxation upon those who can best bear up under it. This is a record that no nation has excelled. It is a record that shows purpose, an unflinching purpose."

Secretary Wilson, in expressing the Government's attitude toward labor, said:

"Many of you are wondering why there is a spirit of unrest among the workers of the country. Many of the troubles which have come from this unrest we have been able to adjust before they reached the strike stage, by negotiation along the lines I have outlined to you. Did it ever occur to you that the greatest reason for the unrest that exists among the workingmen of this country is that the story has gone forth that corporations engaged in the iron and steel industries, for instance, are making a profit of from 200 to 400 per cent.; that corporations engaged in the shipbuilding industry are making enormous profits, and that corporations engaged in the mining and lumbering industries are making enormous profits?

"In other words, did it ever occur to you that the story has gone forth that business men are not patriotic? That they have been 'profiteering'? And did it ever occur to you that the workingman has said to himself that he will insist on getting his share of the 'swag'? Now, my position is that there should be no 'swag' to share between capital and labor."

British Rules for Economy in Coal Transportation

The Controller of Coal Mines announces a new ruling, with the object of saving 700,000,000 ton-miles annually in the transport of coal by railway. For this purpose Great Britain has been divided into 20 areas, relating solely to coal which is being transported from area to area for inland consumption, but does not affect water-borne coal or coal for export, bunker fuel, anthracite or coke of any description.

It is based on four main issues: (1) That consumption of coal should take place as near the producing point as possible; (2) that in view of the superior facilities afforded by the main trunk lines, the movement of traffic should follow these routes wherever possible; (3) that the movement of coal should, as far as possible, be in well-defined directions, namely, north to south, north to southeast, north to southwest or east to west; (4) that an area producing a smaller quantity of coal than suffices for its own needs should not send any portion of its output to other areas, and that an area producing more coal than it requires for consumption within the area itself should distribute the balance only to adjacent or convenient areas.

The consumption of coal will be restricted, as far as practicable, to the area in which it is produced, but in the case of noncoal-producing areas (such as London and the home counties) it will be permissible to obtain supplies from the nearest point of coal production. A special concession will be made, however, in cases in which it is necessary to provide fuel of a special type for certain purposes. In this connection arrangements are being made for the issue of certificates authorizing such supplies when required by steam raisers for mechanical stokers, gas producers, etc. The movement of coal within the areas themselves (that is, coal produced and consumed in the same area) will remain undisturbed so far as these new regulations are concerned, and contracts coming within this category may continue to be operative. With these exceptions, every contract for the sale of coal will be abrogated and new contracts will come into operation.

Apprehension has been felt that this might result in enhancing the price of coal, but it is stated that the question of prices will be in the hands of the Coal Controller's Department, who will be bound by the coal-prices limitation act.—*Commerce Reports.*

Ethyl Alcohol from Wood Not Injurious

There is no reason for discriminating against ethyl alcohol made from wood in favor of that from grain or molasses, according to the Government chemists of the Forest Products Laboratory at Madison, Wis. The impurities in commercial ethyl alcohol, they say, are small in amount and probably less objectionable when wood is used as a base than when grain or molasses is used. The prejudice against the use for some purposes of ethyl alcohol made from wood is probably accounted for, the experts say, by a confusion with methyl, or "wood," alcohol, which is poisonous. While both products are derived from wood, they are radically different. The ethyl, or grain, alcohol is made by reducing the wood to sawdust, treating the sawdust with an acid to produce chemical sugars, and converting the fermentable sugars into alcohol by fermentation, as in the case of grain or molasses. Wood alcohol, however, is obtained by condensing certain gases that are liberated when the wood is heated in air-tight retorts, so that it decomposes without burning. Ethyl alcohol has, it is stated, been commercially manufactured from wood for several years in this country. It is suitable for any use to which ethyl alcohol from any other base is put. Improvements on the processes which have been developed at the Forest Products Laboratory have made it possible to decrease the former cost of production.

Personals

W. E. Firth, safety engineer of the Midvale Steel Co., Nicetown, Philadelphia, has resigned his position.

H. J. Richardson has been appointed works engineer of the Berger Manufacturing Co., Canton, Ohio.

Charles Poethke, who has been chief smoke inspector of Milwaukee since 1904, has been reappointed for another four-year term. He is a charter member of the International Association of Smoke Prevention.

W. D. Robb, formerly superintendent of motive power of the Grand Trunk Ry., has been appointed vice president in charge of motive power, car equipment and machinery, with headquarters at Montreal, Can. He is succeeded in his former position by W. H. Sample.

William N. Finley, who for many years was assistant to the late Henry G. Stott, superintendent of motive power, Interborough Rapid Transit Co., New York City, has been appointed to the position left vacant by Mr. Stott's death. Mr. Finley was associated with Mr. Stott in the latter's pioneer power-plant work, and is familiar with the organization whipped into shape by Mr. Stott.

Miscellaneous News

Power and Heavy Road Making and contracting machinery are to make up the entire exhibits of one of the large buildings of the Real Estate and Building Show, which is to be held in Columbus, Ohio, Jan. 21-30, 1918. Three of the largest connected buildings at the Ohio State Fair Grounds will be utilized for this purpose. Furnaces are now being installed and all improvements necessary to make the buildings comfortable for winter exhibition purposes are being made. The projectors of the show, the Columbus Builders and Traders Exchange, the Columbus Real Estate Board and allied interests, plan to make this the most complete building show ever produced. Interest will not be confined solely to the city, but state and national exhibitors will be represented. A number of the building-trades organizations plan to hold their winter conventions in Columbus during the show.

Engineering Affairs

The American Institute of Electrical Engineers will hold its 333rd meeting in Philadelphia, Oct. 8, under the auspices of the Philadelphia Section, with headquarters at the Bellevue-Stratford Hotel. The general subject of the meeting will be Industrial Research, and papers will be presented by Dr. F. B. Jewett, C. E. Skinner and Dr. E. A. Kennelly. There will be an afternoon and evening session with an informal dinner between the sessions.

The American Institute of Steam Boiler Inspectors of New York City will hold its next meeting at the Engineering Societies Building, 29 West 39th St., on Thursday evening, Oct. 25 (instead of the last Friday evening in the month as usual). Stereopticon slides will be shown by Lewis Jones, Associate Editor of "Power," illustrating as many as possible (in one evening) of the processes in the manufacture of iron and steel. Non-members are invited.

The Steel Treating Research Club will hold a meeting in the rooms of the Detroit Engineering Society on the evening of Oct. 6, at which Bradley Stoughton will present an illustrated paper on the "Possibilities of Double Heat Treatment." The club will also hold a meeting in the same rooms on the evening of Oct. 19, at which Hugh Lamont will present an illustrated paper on "The Shell Industry in Canada from Its Inception Down to Date," with special attention to the heat-treatment of the steel.

National Fire Protective Association—By direction of Chairman Francis E. Cabot the electrical committee of the National Fire Protective Association is requested to reconvene on Tuesday and Wednesday, Oct. 23 and 24, 1917, beginning at 10 a.m., at the rooms of the New York Board of Fire Underwriters, 123 William St., New York City. Matters to be considered are those listed in the Bulletin for Mar. 28 and 29, 1917, meetings, issued under date of Feb. 15, 1917. It will be recalled that the March meetings were adjourned, subject to the call of the chairman, shortly after opening, on account of an injunction issued to a fuse-manufacturing company.

Obituary

William P. Hancock, superintendent of the generating department of the Edison Electric Illuminating Co., of Boston, Mass., and one of the best-known power-plant executives in the United States, died at his home in Boston, Sept. 19. "Bill" Hancock, as he was familiarly known by a large circle of friends, was 61 years of age on Sept. 17. He had not been well since last winter and had only just returned from a long visit to his old home in Biddeford, Me., with the expectation of resuming his duties with the Edison company Oct. 1. On May 10 of this year he rounded out a quarter of a century in the employ of the company. Mr. Hancock was born at Kennebunk, Me., received his early education in Saco, Me., and later spent seven years with his father in the millwright trade. For four years he was employed in the United States Navy Yard at Kittery, Me., where he learned the brass and iron molder's trade. This was followed by a year with the York Manufacturing Co., during which time he was associated with the installation of an Edison plant for the first time, which so interested him that he determined to make electricity his profession. He began this in New York City, with the New York Edison Co., and the wiring of Columbia College was an episode of his early experience. Later he was in charge of the wiring installation work at the Government Printing Office in Washington. Mr. Hancock's advancement eventually brought him to Boston, where he wired the Bijou Theater in 1886, afterward traveling widely in his work of wiring installation. On one of his trips to Boston he worked on the equipment of the Edison station on Atlantic Ave., and since that time has been actively employed by the company, rising from post to post to the head of the important department which he so long adorned. Mr. Hancock was one of the most businesslike of engineers; his disposition of matters passing before him was remarkable for its promptness of decision, its soundness in technical detail and its broad grasp of power-plant economic principles. His office table and desk were kept so bare of papers as to attract the comment of visitors, and he inspired the confidence and loyalty of his organization to a very unusual degree. He was a National Electric Light Association medalist some years ago, presenting a classic paper on underground construction before the convention. He is survived by his widow and was a member of the Boston Yacht Club, the Engineers' Club of Boston and various fraternal orders.

Trade Catalogs

Casings for Link-Belt Silent Chain Drives. Link-Belt Co., 39th St. and Stewart Ave., Chicago, Ill. Book No. 342. Pp. 6; 6x9 in.; illustrated.

Volute Centrifugal Pumps. Worthington Pump and Machinery Corp., 115 Broadway, New York. Bulletin W-600-A. Pp. 32; 6x9 in.; illustrated.

Turbine Pumps for High Head Service. Worthington Pump and Machinery Corp., 115 Broadway, New York. Bulletin W-602. Pp. 32; 6x9 in.; illustrated.

Single and Multistage Steam Turbines and Reduction Gears. Moore Steam Turbine Corp., Wellsville, N. Y. Bulletin No. 3. Pp. 16; 6 x 9 in.; illustrated.

Condit Electrical Protective Devices. Condit Electrical Manufacturing Co., So. Boston, Mass. Bulletins Nos. 413, 414, 415-1-2-4-5, 416 and 417-1, describing and illustrating oil switches and circuit-breakers, transformers, etc.

Water-Tube Boilers. Union Iron Works, Erie, Penn. Catalog. 7x10 in.; illustrated. This contains a boiler-efficiency test on two boilers installed at the New York Central R.R. Co.'s plant at Depew, N. Y.

Electrical Supply Year-Book. Western Electric Co., 195 Broadway, New York. Pp. 1160; 7x10 in.; illustrated. This follows the plan of uniform list prices and basic discount inaugurated by this company three years ago, and in addition manufacturers' list prices are shown on certain standard lines.

The Control and Protection of Small Induction Motors. Condit Electrical Manufacturing Co., South Boston, Mass. Publication No. 1003. Pp. 8; size 8 x 11 in. This booklet gives important information on the protection of small induction motors by the use of inclosed fuses covering such points as improper application of protective devices, starting characteristics of induction motors, fuse characteristics, recommendations for fuse protection of induction motors, etc.

Business Items

The Crane Packing Co., of Chicago, announces the establishment of an office in the Woolworth Building, New York City, with its engineer, A. W. Payne, in charge of the branch.

Frank L. Patterson & Co. and **Benj. F. Kelley & Son** announce a combination of their interests. Hereafter their joint business will be conducted under the name of the Patterson-Kelley Co., Inc., at 26 Cortlandt St., New York City.

The Homestead Valve Manufacturing Co., of Homestead, Penn., has almost completed the rebuilding of its manufacturing plant and office buildings, which will give it about 75 per cent. additional space to take care of increasing business.

Coal Exports to Canada—The Fuel Administrator has issued a circular to coal operators and others engaged in or desiring to engage in the shipment of coal from the United States into Canada, requiring a notice of such intention, setting forth the following information: (1) The amount in tons (2000 lb. for bituminous and 2240 lb. for anthracite) which the exporter desires to ship, (2) the amount of such shipment he expects to make during each of the 12 calendar months beginning Sept. 1, 1917, (3) the route or routes and amount of each kind of coal by each route, (4) the general division, district or province to which shipments are desired to be made and approximate amount of each kind, (5) the tonnage of each kind of coal for which the exporter has orders on hand for shipment to Canada, (6) the amount in tons which the exporter shipped to Canada in each of the 12 months ended Aug. 31, 1917, (7) the route or routes by which he shipped such coal, (8) the general division, district or province to which such shipments were made and (9) the name of each consignee, the location to which each consignment was made and the total amount of coal shipped to each consignee. Except for good cause, and upon written application, no person failing to comply with the foregoing requirements will be permitted to ship or sell for shipment to Canada any coal from any point in the United States unless specifically licensed by the Exports Administrative Board. Exporters who comply with the terms of the notice will be advised at an early date of the regulations under which shipments are thereafter to be made, and in the meantime may continue their shipments as heretofore. Official copies of the circular may be obtained from the office of the United States Fuel Commission, Washington, D. C.

New Publications

NEW BUREAU OF STANDARDS PUBLICATIONS

The Bureau of Standards is distributing free upon request Technologic Paper No. 83, entitled "Failure of Brass. 2. Effect of Corrosion on the Ductility and Strength of Brass." A study has been made of the effect of tensile stress on the electrolytic solution potential of brass to various solutions, the results indicating an increase of electromotive force of about 0.1 millivolt for 10,000 lb. per sq.in. of stress. An explanation is given, based upon this effect, of the decreased ductility and strength exhibited by brass when corroded while under tensile stress, and the growth of fissure in brass under such conditions is described.

The bureau also has ready for distribution Technologic Paper No. 84, entitled "Failure of Brass. 3. Initial Stress Produced by the 'Burning-In' of Manganese Bronze." Investigation has been made of the initial stress produced by the burning-in, without preheating, of constrained parts of castings of manganese bronze. Results have shown that, in general, tensile stresses will be produced within the burning-in area, equal in value to the true elastic limit of the material. The conclusion is drawn that burning-in of such material should not be practiced without thorough preheating or subsequent annealing of the whole casting.

THE COAL MARKET

Boston—Current quotations per gross ton delivered alongside Boston points as compared with a year ago are as follows:

ANTHRACITE

	Circular[1]		Individual[1]	
	Sept. 29, 1917	One Year Ago	Sept. 29, 1917	One Year Ago
Buckwheat ..	$4.98—5.20	$2.05—3.20	$7.10—7.35	$3.25—3.50
Rice	4.40—4.65	2.50—2.65	6.65—6.90	2.70—2.95
Boiler	.....	.....	.....	.....
Barley	3.90—4.15	2.20—2.35	6.15—6.40	2.35—2.60

BITUMINOUS

Prices per gross ton for Boston delivery are as follows:

	F.o.b. Mines*		Alongside Boston†	
	Sept. 29, 1917	One Year Ago	Sept. 29, 1917	One Year Ago
Clearfields ...	$4.15—4.50	$1.15—1.75	$8.00—8.35	$4.25—5.00
Cambrias and Somersets...	4.40—4.75	1.45—1.90	8.25—8.50	4.60—5.40

Pocahontas and New River, f.o.b. Hampton Roads, is $4.02—4.19, as compared with $2.85—2.90 a year ago; on cars Boston price is $8.75—9.00.

*All-rail rate to Boston is $2.60. †Water coal.

New York—Current quotations per gross ton f.o.b. Tidewater at the lower ports* as compared with a year ago are as follows:

ANTHRACITE

	Circular[1]		Individual[1]	
	Sept. 29, 1917	One Year Ago	Sept. 29, 1917	One Year Ago
Buckwheat ..	$3.95—4.65	$2.75	$4.75—5.00	$2.75—3.00
Rice	3.40—3.60	2.20	3.25—3.40	2.10—2.20
Barley	2.90—3.15	1.95	2.35—2.50	1.85—1.95

Quotations at the upper ports are about 5c. higher.

BITUMINOUS

	F.o.b. Sept. 29, 1917	Mine Prices One Year Ago
Bunker coal	$6.00—6.25	$4.00—4.50
Commercial	5.25—6.00*	3.00

*Based on Federal Trade Commission suggestion.

*The lower ports are: Elizabethport, Port Johnson, Port Reading, Perth Amboy and South Amboy. The upper ports are: Port Liberty, Hoboken, Weehawken, Edgewater or Cliffside and Guttenberg. St. George is in between and sometimes a special boat rate is made. Some bituminous is shipped from Port Liberty. The freight rate to the upper ports is 5c. higher than to the lower ports.

Philadelphia—Prices per gross ton f.o.b. cars at mines for line shipment and f.o.b. Port Richmond for tide shipment are as follows:

	Line		Tide	
	Sept. 29, 1917	One Year Ago	Sept. 29, 1917	One Year Ago
Buckwheat ...	$2.90	$1.65	$3.80	$2.55
Rice	2.40	1.00	3.40	1.90
Boiler	2.20	.90	3.30	1.80
Barley	1.90	.75	2.15	1.65

Pittsburgh—Price of steam coal per net ton f.o.b. mine, Pittsburgh district:

	Sept. 29, 1917	One Year Ago
Slack	$3.00—3.25	$1.20—1.40
Mine-run	3.00—3.25	1.65—1.75
¾-in.	3.50—3.75	1.75—1.85

Add 40c. per ton for freight charge to Pittsburgh.

Chicago—Current prices per net ton f.o.b. mines are as follows:

	Williamson and Franklin Counties	Saline and Harrisburg	West Virginia Smokeless	Springfield	Clinton and Sullivan Counties
Steam lump ..	$2.20	$2.20	$2.25	$2.20	$2.20
Lump	2.20	2.20	2.25	2.20	2.20
Egg	2.20	2.20	2.25	2.20	2.20
Nut	2.20	2.20	....	2.20	2.20
No. 1 nut....	2.20	2.20	....	2.20	2.20
No. 2 nut....	2.20	2.20	....	2.20	2.20
No. 3 nut....	2.20	2.20	....	....	....
No. 1 washed.	2.20	2.20	....	....	....
No. 2 washed.	2.20	2.20	....	....	....
Mine-run	1.95	1.95	2.10	1.95	1.95
Screenings	1.75	1.70	1.90	1.70	1.70

Hocking lump, $2.60; splint lump, $2.40.

Northern Illinois thin vein—Prepared sizes, $2.65; mine-run, $2.40; screenings, $2.15.

St. Louis—Prices pet net ton f.o.b. mines a year ago as compared with today are as follows:

	Williamson and Franklin Counties		Mt. Olive and Staunton		Standard	
	Sept. 29, 1917	One Year Ago	Sept. 29, 1917	One Year Ago	Sept. 29, 1917	One Year Ago
6-in. lump ..	$2.20	$2.00	$2.20*	$1.75	$2.20	$1.65
2-in. lump..	2.20	1.50	2.20*	1.40	2.20	1.10
Steam egg...	2.20	1.50	2.20*	1.40	2.20	1.10
Mine-run ...	1.95	1.40	1.95*	1.25	1.95	1.15
No. 1 nut..	2.20	1.60	2.20*	1.75	2.20	1.25
2-in. screen.	1.70	1.00	1.70*	1.00	1.70	.90
No. 5 washed	1.70	.90	1.70*	.75	1.70	.75

*Strike.

Williamson-Franklin rate St. Louis, 72½c.; other rates, 57½c.

Birmingham—Current prices per net ton f.o.b. mines are as follows:

	Mine-Run	Lump and Nut	Slack and Screenings
Big Seam	$1.90	$2.15	$1.65
Pratt, Jagger, Corona....	2.15	2.40	1.90
Black Creek, Cahaba ...	2.40	2.65	2.15

Government figures.

[1]Individual prices are the company circulars at which coal is sold to regular customers irrespective of market conditions. Circular prices are generally the same at the same periods of the year and are fixed according to a regular schedule.

PROPOSED CONSTRUCTION

Ariz., Thatcher—The city plans to install an electric-light pla .t.

Calif., Arcata—The Western States Electric Co., of Eureka, 318 5th St., Eureka, plans to rebuild its entire system here. E. W. Naileigh, Ch. Engr.

Calif., Pittsburg—The Great Western Power Co., 14 Sansome St., San Francisco, contemplates an expenditure of $100,000 for outdoor type substation and other improvements at Valona.

Fla., Lake Worth—City Commissioners voted in favor of a bond issue for $15,000 for the installation of an electric-lighting system.

Idaho, Jerome—The Idaho Power Co. plans to construct an 80-mile power line from here to Jarbridge, Nev.

Kan., Caney—The Kansas Light and Power Co., recently organized by H. A. Carmichael, of Duluth, Minn., has taken over the plant of the Caney Electric Light and Ry. Co. The new owners will rebuild the plant and install new machinery.

Kan., Protection—City will rebuild the electric-light plant recently destroyed by fire with a loss of $25,000.

Ky., Louisville—The American Tobacco Co., 18th St. and Broadway, plans to construct an addition to its power plant. Estimated cost, $8000. D. X. Murphy & Bro., 713-20 Louisville Trust Bldg., Arch.

Mich., Grand Rapids—The Consumers Power Co. will rebuild its power plant here. Estimated cost, $20,000. C. W. Tippy, Jackson, Gen. Mgr.

Miss., Scooba—Town Council plans to install a new electric-lighting system.

Mont., Malta—City Council passed an ordinance to install a street-lighting system. Estimated cost, $45,000.

Neb., Dunbar—Citizens voted in favor of $7000 bond issue for installing an electric-light plant. Noted Aug. 28.

N. J., Trenton—Bids will be received by the City Commission until Oct. 5 for furnishing a heating boiler of 1800 sq.ft. for water department building at reservoir. L. D. Hirsch, City Clk.

Nev., Carson City—The Nevada Valleys Power Co., First National Bank Bldg., Oakland, Calif., plans to construct a hydro-electric plant on the Truckee River and transmission lines to cover a large section of western Nevada. The company has secured the franchise for the plant. Estimated cost, $300,000.

N. Y., New York—(Borough of Manhattan)—The Interborough Rapid Transit Co. has acquired a site on East 18th St. adjoining its power plant and will construct an addition. The company also plans to build a new transformer station on West 16th St.

N. Y., White Plains—The Westchester Street Ry. Co., 129 Church St., New Haven, Conn., plans to construct a 2-story operating plant on Main St. P. W. Ripple, Engr.

N. C., Maxton—City plans to install a new electric-light plant.

O., Caledonia—City plans to install an electric-lighting system. Estimated cost, $10,000.

O., Cincinnati—The National Lead Co., Freeman Ave. and Cincinnati, Hamilton & Dayton Ry., plans to construct a 3-story reinforced-concrete power plant. Estimated cost, $50,000.

Ore., Sumpter—The Sumpter Power and Water Co. plans to reconstruct its plant.

Penn., Chalfont—Plans are being considered by the Borough Officials for the installation of a new electric-lighting system.

Penn., Philadelphia—The Pennsylvania Chemical Works will construct an addition to its power plant on Washington Ave. Estimated cost, $25,000.

Penn., Philadelphia—Pennsylvania R.R. is having plans prepared for a 1-story, 35 x 51-ft. addition to its boilerhouse at its West Philadelphia shops. A. C. Shand, Broad St. Sta., Ch. Engr.

Penn., Philadelphia—The Henry M. Sheip Manufacturing Co. 6th and Columbia St., plans to construct an addition to its power plant.

Penn., Philadelphia—M. Zifferblatt, 2115 South 8th St., plans to install new power-plant equipment in his factory at 4th and Cherry Sts.

Penn., Pittsburgh—The Duquesne Light Co., 435 6th Ave., has been granted permission by the Public Service Commission to issue $3,271,250 securities to be used for extensions and improvements and existing obligations.

Penn., Pottstown—The Industrial Foundry and Machine Co. will construct a new boiler house at its works here.

Va., Norton—The Old Dominion Power Co. will construct transmission lines between Norton and the new mines of the Wolf Pen Coal Co. and the Omboden Coal and Coke Co., at Tacoma and Esserville. The company also plans transmission lines between Norton and Osaka, Minersville, Inman and Imoden in Wise County.

W. Va., Raleigh—Chesapeake & Ohio Ry. plans to construct new power house at its works here. L. B. Allen, Huntington, Gen. Supt.

Wash., Everett—City has secured a site of 100 acres of land in the Horse Shoe Bend on the Sultan River on which a power plant will be constructed. H. Mumm, Jr., City Engr.

Wash., Skykomish—City plans to install an electric-light and power plant. Estimated cost, $7000.

B. C., Victoria—The Surf Inlet Power Co. will build a concentrator on Surf Inlet. Estimated cost, $500,000.

Ont., Georgetown—J. B. Mackenzie is in the market for an electric motor, 5 to 7½ hp., 25 cycle, 220.

Que., Quebec—Eugene, Julien & Cie, Ltd., 1200 St. Valier St., will construct a concrete block and brick boiler house. Estimated cost, $9000.

Prices—Materials and Supplies

These are prices to the power plant by jobbers in the larger buying centers east of the Mississippi. Elsewhere the prices will be modified by increased freight charges and by local conditions.

ELECTRICAL SUPPLIES

KNIFE SWITCHES—Following are net prices each in cities named for knife switches mounted on slate base, front connected, punched clip type, 250 volts:

	30 Amp.	60 Amp.	100 Amp.	200 Amp.
D. P. S. T. fuseless	$0.52	$0.93	$1.90	$3.42
D. P. S. T. fused	.81	1.37	2.70	5.14
D. P. D. T. fuseless	.88	1.52	3.42	5.70
D. P. D. T. fused	1.67	2.58	5.62	9.88
T. P. S. T. fuseless	.78	1.40	2.86	5.14
T. P. S. T. fused	1.22	2.05	4.18	7.70
T. P. D. T. fuseless	1.37	2.35	5.24	8.82
T. P. D. T. fused	2.68	4.13	8.99	15.80

Lots $25 and more, list.

FUSES—Following are net prices of 250-volt inclosed fuses each, in standard packages, in cities named:

0-30 amperes	$0.11¼ each	110-200 amperes	$0.90 each
31-60 amperes	.15¾ each	225-400 amperes	1.62 each
61-100 amperes	.40 each		

FUSE PLUGS (MICA CAP) PER 100

0-30 amperes.. 4c. each in standard package quantities (500)
0.30 amperes.. 5c. each for less than standard package quantities (500)

SOCKETS, B. B. FINISH—Following are net prices in cents each in standard packages:

⅛-IN. OR PENDANT CAP			¾-IN. CAP		
Key	Keyless	Pull	Key	Keyless	Pull
22.10c.	21.00c.	42.00c.	27.30c.	26.20c.	46.20c.

Note—Less than standard package quantities, 15% off list.

CUT-OUTS—Following are net prices each in standard-package quantities:

CUT-OUTS, PLUG

S. P. M. L.	$0.11	T. P. to D. P. S. B.	$0.24
D. P. M. L.	.18	T. P. to D. P. T. B.	.38
T. P. M. L.	.26	T. P. S B.	.33
D. P. S. B.	.19	T. P. D. B.	.54
D. P. D. B.	.37		

CUT-OUTS, N. E. C. FUSE

	0-30 Amp.	31-60 Amp.	60-100 Amp.
D. P. M. L.	$0.33	$0.84	$1.68
T. P. M. L.	.48	1.20	2.40
D. P. S. B.	.42	1.05	....
T .P. S. B.	.81	1.80	....
D. P. D. B.	.78	2.10	....
T. P. D. B.	1.35	3.60	....
T. P. to D. P. D. B.	.90	2.52	....

ATTACHMENT PLUGS—Price each, in standard packages:

		Standard Package
Hubbell porcelain	$0.21	250
Hubbell composition	.12	50
Benjamin swivel	.12	..
Current taps	.35	50

FAN MOTORS—In quantities of 25 to 100, four-blade fans for alternating and direct current sell as follows:

	Non-Oscillating		Oscillating	
In. Diameter	60-Cycle A.C.	110-V. D.C.	60-Cycle A.C.	110-V. D.C.
9	$8.50	$8.00	$13.25	$11.00
12	12.80	11.50	16.50	14.75
16	15.75	13.50	19.00	17.15

Note—Complete with cord and plug.

FLEXIBLE CORD—Price per 1000 ft. in coils of 250 ft.:

No. 18 cotton twisted	$25.00
No. 16 cotton twisted	36.00
No. 18 cotton parallel	30.00
No. 16 cotton parallel	44.00
No. 18 cotton reinforced heavy	39.00
No. 16 cotton reinforced heavy	53.00
No. 18 cotton reinforced light	35.00
No. 16 cotton reinforced light	47.00
No. 18 cotton Canvasite cord	32.00
No. 16 cotton Canvasite cord	38.00

LOOM—Price per 100 ft., in coils:

Ft. in Coil			Ft. in Coil	
¼	250	$2.25	¾ 150	$7.00
⅜	250	3.50	1 100	10.00
½	200	4.50	1¼ 100	12.00
⅝	200	5.75	1½ 100	15.00

RUBBER-COVERED COPPER WIRE—Per 1000 ft. in New York:

No.	Solid, Single Braid	Solid, Double Braid	Stranded, Double Braid	Duplex
14	$12.00	$15.00	....	$27.00
12	17.75	19.35	....	39.00
10	24.30	26.75	....	75.00
8	34.50	37.28	....	....
6	....	....	$64.85	....
5	....	....	76.75	....
4	....	....	92.64	....
3	....	....	112.00	....
2	....	....	135.75	....
1	....	....	175.00	....
0	....	....	267.00	....
00	....	....	330.00	....
000	....	....	405.00	....
0000	....	....	491.00	....

COPPER WIRE—Prices per 1000 ft. for rubber-covered wire in following cities:

	Denver			St. Louis			Birmingham		
No.	Single Braid	Double Braid	Duplex	Single Braid	Double Braid	Duplex	Single Braid	Double Braid	Duplex
14	$12.25	$15.20	$29.75	$14.00	$16.00	$28.00	$15.00	$18.80	$33.84
10	24.50	27.70	54.95	28.30	31.80	63.85	31.80	21.77	63.54
8	34.90	38.50	76.80	40.70	44.70	88.90	40.82	44.41	....
6	....	59.10	....	....	69.10	....	63.62	68.77	....
4	....	85.15	....	....	110.35	....	94.50	99.72	....
2	....	127.50	....	....	161.00	....	146.25	152.10	....
1	....	165.35	....	....	211.00	....	187.65	195.30	....
0	....	198.55	....	....	256.50	....	257.40	265.95	....
00	....	267.05	....	....	316.00	....	316.35	325.80	....
000	....	327.35	....	....	385.00	....	389.25	399.60	....
0000	....	399.60	....	....	469.50	....	475.00	486.90	....

CONDUITS, ELBOWS AND COUPLINGS—Following are warehouse net prices per 1000 ft. for conduit and per unit for elbows and couplings:

	Conduit		Elbows		Couplings	
In.	Enameled	Galvanized	Enameled	Galvanized	Enameled	Galvanized
½	$69.70	$74.80	$0.1672	$0.1786	$0.0616	$0.0658
¾	92.00	98.90	.22	.235	.088	.094
1	136.00	146.20	.3256	.3478	.1144	.1222
1¼	184.00	197.80	.4185	.4496	.1581	.1698
1½	220.00	236.50	.558	.5994	.1953	.2098
2	296.00	318.20	1.023	1.10	.2604	.2797
2½	468.00	503.10	1.674	1.80	.372	.3996
3	612.00	657.90	4.464	4.79	.558	.5994
3½	763.60	818.80	9.86	10.59	.744	.7992
4	926.50	991.90	11.39	12.23	.93	.999

Standard lengths rigid, 10 ft. Standard lengths flexible, ½ in., 100 ft. Standard lengths flexible, ¾ to 2 in., 50 ft.

LOCKNUTS AND BUSHINGS—Following are net prices in standard packages, which are: ½-in., 1000; ¾- to 1¼-in., 100; 1½- to 2-in., 50:

	Locknuts Per 100	Bushings Per 100	Flexible Conduit Box Connections Per 100
½	$1.02	$1.68	$5.62
¾	1.75	4.00	7.12
1	3.00	6.15	10.50
1¼	5.00	8.20	15.00
1½	7.50	10.25	22.50
2	10.00	16.40	30.00
2½	12.30	24.60	67.50

ARMORED CABLES AND BOX CONNECTORS—Following are net prices per 1000 ft. cable and standard package of 100 box connectors in single and double strip:

	Twin Conductor		Three Conductor	
Wire Gage	Cable	Connectors	Cable	Connectors
14	$76.00	$4.50	$103.50	$4.50
12	101.25	4.50	127.50	4.50
10	138.75	4.75	176.25	4.75
8	176.20	5.75	247.50	6.00
6	277.50	6.25	362.40	7.50
4	431.25	7.50	....	....

LAMPS—Below are present quotations in less than standard package quantities:

Straight-Side Bulbs				Pear-Shape Bulbs			
Mazda B—			No. in	Mazda C—			No. in
Watts	Plain	Frosted	Package	Watts	Clear	Frosted	Package
10	$0.27	$0.30	100	75	$0.65	$0.70	..
15	.27	.30	100	100	1.00	1.05	24
25	.27	.30	100	300	3.00	3.10	24
40	.27	.30	100	500	4.50	4.65	12
50	.27	.30	100	750	6.00	6.25	8
60	.36	.40	100	1000	7.00	7.25	8

Standard package quantities are 10% from above prices. Yearly contracts ranging from $150 up allow a discount of 17% from list.

WIRING SUPPLIES—New York prices for tape and solder are as follows:

Friction tape, ½-lb. rolls	35c. per lb.
Rubber tape, ½-lb. rolls	45c. per lb.
Wire solder, 50-lb. spools	35c. per lb.
Soldering paste, 1-lb. cans	50c. per lb.

MISCELLANEOUS

HOSE—

	Fire 50-Ft. Lengths
Underwriters' 2½-in.	70c. per ft.
Common, 2½-in.	40-10%

	Air		
	First Grade	Second Grade	Third Grade
¾-in., per ft.	$0.55	$0.30	$0.25

Steam—Discounts from list

First grade... 30% Second grade... 30-5% Third grade... 40-10%

RUBBER BELTING—The following discounts from list apply to transmission rubber and duck belting:

Competition ..... 50-10% Best grade 25%
Standard 40%

LEATHER BELTING—Present discounts from list in the following cities are as follows for cut lengths:

	Medium Grade	Heavy Grade
New York	40%	35%
St. Louis	45%	40%
Chicago	40—5%	35—10%
Birmingham	35%	35%
Denver	40%	35%

RAWHIDE LACING—40%.

PACKING—Prices per pound:

Rubber and duck for low-pressure steam	$0.77
Asbestos for high-pressure steam	1.54
Duck and rubber for piston packing	.88
Flax, regular	.66
Flax, waterproofed	.99
Compressed asbestos sheet	.99
Wire insertion asbestos sheet	1.21
Rubber sheet	.55
Rubber sheet, wire insertion	.88
Rubber sheet, duck insertion	.44
Rubber sheet, cloth insertion	.25
Asbestos packing, twisted or braided, and graphited, for valve stems and stuffing boxes	1.10
Asbestos wick, ½- and 1-lb. balls	.65 to .70

PIPE AND BOILER COVERING—Below are discounts and part of standard lists:

PIPE COVERING		BLOCKS AND SHEETS	
Pipe Size	Standard Thickness Per Lin.Ft.	Thickness	Price per Sq.Ft.
1-in.	$0.27	½-in.	$0.27
2-in.	.36	1 -in.	.30
6-in.	.80	1½-in.	.45
4-in.	.60	2 -in.	.60
3-in.	.45	2½-in.	.75
8-in.	1.10	3 -in.	.90
10-in.	1.30	3½-in.	1.05

85% magnesia high pressure ..... 15% off

For low-pressure heating and return lines { 4-ply ..... 58% off; 3-ply ..... 60% off; 2-ply ..... 62% off

GREASES—Prices are as follows in the following cities in cents per pound for barrel lots:

	New York	Denver	Chicago	Birmingham	St. Louis
Cup	5 to 7	9½	7½	5½	5.6
Fiber or sponge	5 to 7	15	7¾	12½	5.9
Transmission	5 to 7	13	6¼	12½	5.9
Axle	3 to 7	5	5	4½	3.3
Gear	4 to 5	4½	6½	10½	6
Car journal	5½ to 7¼	4	6	9	3.75

WIPING CLOTHS—In Cleveland the jobbers' price per 1000 is as follows:

13¼ x 13¼ ..... $35.00 13¼ x 20½ $45.00

In Chicago they sell at $30@33 per 1000.

COTTON WASTE—The following prices are in cents per pound:

	New York			
	Sept. 29, 1917	One Year Ago	Cleveland	Chicago
White	11.00@12.00	12.50	16.00	14.00@15.00
Colored mixed	8.50@12.00	9.00	14.00	10.00@12.00

LINSEED OIL—These prices are per gallon:

	New York		Cleveland		Chicago	
	Sept. 29, 1917	1 Year Ago	Sept. 29, 1917	1 Year Ago	Sept. 29, 1917	1 Year Ago
Raw in barrels	$1.26	$0.73	$1.30	$0.77	$1.27	$0.75
5-gal. cans	1.36	.83	1.40	.87	1.37	.85

WHITE AND RED LEAD in 500-lb. lots sell as follows in cents per pound:

	Red				White			
	Sept. 29, 1917		1 Year Ago		Sept. 29, 1917		1 Yr. Ago	
	Dry	In Oil	Dry	In Oil	Dry and In Oil		Dry and In Oil	
100-lb. keg	12.25	12.50	10.50	11.00	12.00		10.50	
25- and 50-lb. kegs	12.50	12.75	10.75	11.25	12.25		10.75	
12½-lb. keg	12.75	13.00	11.00	11.50	12.50		11.00	
1- to 5-lb. cans	14.25	14.50	12.50	12.50	14.50		12.50	

RIVETS—The following quotations are allowed for fair-sized orders from warehouse:

	New York	Cleveland	Chicago
Steel ⅞ and smaller	30%	30%	40%*
Tinned	30%	30%	40%*

*For less than keg lots the discount is 35%.

Button heads, ¾, ⅞, 1 in. diameter by 2 in. to 5 in. sell as follows per 100 lb.:

New York ..... $7.00 Cleveland ..... $6.85 Chicago $5.50

Coneheads, same sizes:

New York ..... $7.10 Cleveland ..... $6.95 Chicago $5.60

AMMONIA—Below are prices per lb. in cities named:

	New York
26-deg. U.S.P. carboys of 100 lb.	15c.
26-deg. U.S.P. drums of 1000 lb.	13c

Anhydrous ammonia in 100-lb. cylinders costs 30c. per lb. in St. Louis, Chicago and New York.

FIRE BRICK—Quotations on the different kinds in the cities named are as follows, f.o.b. works:

	New York	Chicago
Silica brick, per 1000	$50.00 to 55.00	$55.00 to 60.00
Fire clay brick, per 1000, No. 1	45.00 to 55.00	.....
Magnesite brick, per net ton	135.00 to 145.00	.....
Chrome brick, per net ton	135.00	.....
Deadburned magnesite brick, per net ton	85.00 to 90.00	.....
Special furnace chrome brick, per net ton	60.00 to 70.00	60.00 to 80.00

Standard size fire brick, 9 x 4½ x 2½ in. The second quality is $4 to $5 cheaper per 1000.

St. Louis—High grade, $55 to $65; St. Louis grade, $40 to $50.

Birmingham—Fire clay, $25 to $30; Denver, $23, per 1000.

FUEL OIL—Price variable, depending upon stock. New York quotations not available owing to this fact. In Chicago and St. Louis the following prices are quoted:

	Chicago	St. Louis
Domestic light, 22-26 Baumé	7¾c.	8.5c.

Note—There is practically no fuel oil in Chicago at present time.

OIL—Price per 50-gal. bbl. is as follows:

City	Fuel	Black	Red Engine	Steam Cylinder	Gasoline
Seattle	$4.45	$6.25	$11.00	$21.00	$10.25
Los Angeles	1.45	6.50	12.00	26.00	10.00
Denver	3.25	8.75	17.00	24.00	12.00
St. Paul	3.00	5.50	11.00	17.50	10.05
Cincinnati	5.00	5.50	10.50	17.00	12.00
Boston	5.25	8.00	12.50	18.75	12.50
Kansas City	6.95	4.35	10.35	17.35	10.15

Note—Standard prices of oil are necessarily difficult to give. Those above are for average grades.

POLES—Prices on Western red cedar poles:

	New York 72-82	Chicago 52-62	St. Louis 52-62	Denver 33-42
6 in. by 30 ft.	$5.50	$4.94	$4.94	$4.32
7 in. by 30 ft.	7.40	6.60	6.60	5.80
7 in. by 35 ft.	10.70	9.60	9.60	8.55
8 in. by 35 ft.	12.20	10.90	10.90	9.65
7 in. by 40 ft.	12.35	11.00	11.00	9.75
8 in. by 40 ft.	13.75	12.15	12.15	10.65
8 in. by 45 ft.	18.20	16.20	16.20	14.30
8 in. by 50 ft.	21.85	19.45	19.45	17.15

PIPE—The following discounts are for carload lots f.o.b. Pittsburgh; basing card of May 1, 1917, for steel pipe, of July 2 for iron pipe:

BUTT WELD

Steel			Iron		
Inches	Black	Galvanized	Inches	Black	Galvanized
⅛, ¼ and ⅜	42%	15½%	¾ to 1½	33%	17%
½	46%	31½%			

LAP WELD

2	42%	29½%	2	26%	12%
2½ to 6	45%	32½%	2½ to 6	28%	15%

BUTT WELD, EXTRA STRONG PLAIN ENDS

⅛, ¼ and ⅜	38%	20½%	¾ to 1½	33%	18%
½	43%	30½%			
¾ to 1½	47%	34½%			

LAP WELD, EXTRA STRONG PLAIN ENDS

2	40%	28½%	2	27%	14%
2½ to 4	43%	31½%	2¼ to 4	29%	17%
4½ to 6	42%	30½%	4½ to 6	28%	16%

Note—National Tube Co. quotes on basing card dated Apr. 1.

Stock discounts in cities named as as follows:

	New York		Cleveland	
	Black	Galvanized	Black	Galvanized
¾ to 3 in. steel butt welded	38%	22%	38%	25%
3½ to 6 in. steel lap welded	18%	List + 20%	23%	39%

	Chicago		St. Louis	
	Black	Galvanized	Black	Galvanized
¾ to 3 in. steel butt welded	38.8%	24.8%	34.27%	19.27%
3½ to 6 in. steel lap welded	42.8%	27.8%	27.27%	13.27%

Malleable fittings, Class B and C, from New York stock sell at list price. Cast iron, standard sizes, 15 and 5%.

BOILER TUBES—Nominal discounts on less than carload lots freight added to point of delivery, effective from Nov. 1, 1916, on standard charcoal iron tubes and from Apr. 2, 1917, on lap-welded steel tubes are as follows:

Lap Welded Steel		Standard Charcoal Iron	
1¾ and 2 in.	31%	1½ in.	23%
2¼ in.	28%	1¾ and 2 in.	35%
2½ and 2¾ in.	34%	2¼ in.	32%
3 and 3½ in.	34%	2½ and 2¾ in.	38%
3½ to 4½ in.	34%	3 and 3¼ in.	43%
5 and 6 in.	33%	3½ to 4½ in.	...
7 to 13 in.	30%	5 and 6 in.	37%
		7 to 13 in.	34%

Above discounts apply to standard gages and to even gages not more than four gages heavier than standard, in standard lengths. Locomotive and steamship special charcoal grades bring higher prices: 1¾ in., over 18 ft. and not exceeding 22 ft., 10 per cent. net extra; 2 in. and larger, over 22 ft., 10 per cent. net extra.

Note—Boiler tubes are practically out of the market. Can be obtained from the mill only on long promises of delivery. Customer will probably have to shop around until he finds a stock.